APPENDIX 14

ENDANGERED AND THREATENED SPECIES BIOLOGICAL ASSESSMENT

YAZOO BACKWATER AREA REFORMULATION

APPENDIX 14
ENDANGERED AND THREATENED SPECIES
BIOLOGICAL ASSESSMENT

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INTRODUCTION

1. This Biological Assessment (BA) evaluates the potential effects of the proposed Yazoo Backwater Reformulation Project on the endangered pondberry (Lindera melissifolia) and the threatened Louisiana black bear (Ursus americanus luteolus). Pertinent biological and ecological data for both species are based on published and unpublished literature, communication with experts, and findings of recent U.S. Army Corps of Engineers investigations.

2. The proposed project is authorized by the Flood Control Act of 18 August 1941.

3. This BA was submitted to the U.S. Fish and Wildlife Service (FWS) pursuant to Section 7 of the Endangered Species Act, as amended. It evaluates the potential effects of the recommended plan only (Plan 5). If the recommended plan is modified or another alternative plan is selected, reevaluation of the potential impacts would be necessary.

PROJECT DESCRIPTION

4. The Yazoo Backwater Area is located in west-central Mississippi and lies between the left bank Mississippi River levee on the west and the Yazoo Basin escarpment on the east. The area, which includes portions of Humphreys, Issaquena, Sharkey, Warren, Washington, and Yazoo Counties, Mississippi, and part of Madison Parish, Louisiana, contains approximately 625,721 acres and is subject to headwater flooding from the Yazoo River, Sunflower River,

Steele Bayou, and backwater flooding from the Mississippi River. A full range of alternative plans was considered. These included nonstructural measures, structural measures, and combined nonstructural and structural measures. The recommended plan includes both structural and nonstructural measures. This plan consists of a 14,000 cubic-foot-per-second (cfs) pump with a year-round pump elevation of 87 feet (approximately 1-year frequency), National Geodetic Vertical Datum, at Steele Bayou drainage structure. Additionally, the plan includes voluntary conservation easements and reestablishment of forest on 62,500 acres of open land below the pump elevation. Pump construction would require the clearing of 38 acres of bottom-land hardwoods for onsite disposal and relocation of the road and bridge. In addition, 110.5 acres of open land and 5.2 acres of open water will be filled as the result of disposal activities.

ENDANGERED AND THREATENED SPECIES ASSESSMENT

PONDBERRY

Description

5. Pondberry was listed Federally as an endangered species on 31 July 1986 (Federal Register 51(47):27495-27500). It is a low growing, deciduous shrub ranging in height from 1.5 to 6 feet. The plants commonly grow in clumps of numerous scattered stems somewhat resembling a "plum thicket." The older portions of the stems are dark green to almost black with numerous irregularly spaced, but prominent lenticels, which appear very similar to saplings or young stems of sassafras (Sassafras albidum). The leaves are drooping and have a distinct sassafras-like odor when crushed. Leaves are 0.75 to 2.5 inches wide and 2 to 6.5 inches long with a round to cordate base. The leaf veins are prominent and the undersurface of the leaf is hairy. The male and female flowers are found on separate plants; flowers of box sexes are pale yellow and small. The flower stalks and buds are often hairy. The fruit is about 0.5 inch long at

maturity, elliptical, and bright scarlet red. The flowers develop in spring before leaves emerge (generally in early March) with mature fruit evident by October. Fruit stalks are often present until next year's flowering (FWS, 1990; Klomps, 1980a; Tucker, 1984).

Taxonomic Status

6. Pondberry is a member of the family Lauracea. It is one of three members of the genus Lindera found in the southeastern United States, which also include Lindera benzoin and Lindera subcoriacea, a new species described by Wafford in 1983.

7. Pondberry was first described as a new species by Tomas Walter in 1788 (Tucker, 1984). The material upon which he based this description was collected from what is present-day Berkeley County, South Carolina (Mercer, 1984).

Range and Population Level

8. Pondberry is presently found in the Mississippi River alluvial plains of Missouri, Arkansas, and Mississippi, and the Coastal Plains region of Georgia, South Carolina, and North Carolina. Historically, pondberry locations have also been reported from Louisiana, Alabama, and western Florida. However, populations of these states are considered extirpated (Tucker, 1984; Wofford, 1983; FWS, 1990). There are 22 currently known locations for pondberry, but the total number of plants is unknown (FWS, 1991).

Life History

9. Pondberry populations are generally associated with the shade of a mature forest and are possibly shade dependent (Klomps, 1980; Tucker, 1984). Pondberry will grown in full sun, but in a stunted condition. Colonies in Mississippi occur in small dense clumps usually averaging less than 0.10 acre in size. Previous field investigations indicated that vigorous healthy colonies

were found in homogeneous clumps with shrub associates growing adjacent to, but not within, the clumps. In less vigorous colonies, shrub/vine associates were usually growing within the clumps.

10. Individual stems within each colony are short-lived, generally dying by their seventh or eighth year. Young stems sprout from the rootstock and replace the dying stems. Over time, colonies may expand vegetatively resulting in many vastly rooted stems. Thus, a typical vigorous colony is composed of numerous relatively tall stems, dead and dying stems, as well as young leaf sprouts. There is little record of new seedling establishment and growth; therefore, colony expansion is suspected to be purely vegetative (Tucker, 1984; FWS, 1990).

11. Individual stems of pondberry begin flowering by their third year of growth (Tucker, 1984). Flowering begins in late February to early March in Mississippi and generally lasts no longer than 2 weeks. Pondberry is dioecious (male and female flowers found on separate plants). A typical colony in Mississippi is composed primarily of male stems with few to several female stems. In some instances, the entire colony is composed of male plants. In general, seed production in relation to the total number of stems is low. Because flowering occurs in late February to early March, frost or near freezing temperatures often damage flowers, thereby reducing fruit production even more. Rayner and Ferral (1988), in a study of 73 colonies from the Honey Hill region of South Carolina, reported that only 22 percent of all colonies surveyed produced fruit, with fruit production averaging only 22 fruits per colony. They also noted that fruit production did not seem to improve with plant health since sexual reproduction appeared to be poor even in large healthy plants.

12. Few details are known about pondberry's breeding system. Pondberry is suspected to be insect pollinated. Tucker (1984) noted small bees and flies on flowers when observing plants in Arkansas. The fruit contains many oils and similar compounds, which are suspected to make

the fruit unpalatable to most wildlife. Therefore, seed dispersal is likely accomplished by seeds merely falling to the ground or by animals (such as birds) picking the fruit and depositing elsewhere (FWS, 1990). Extremely rare occurrences of seedlings have been documented in the wild. J. A. Steyermark reportedly grew pondberry plants from seed in a wildflower garden in Illinois for 10 years before they died out (Klomps, 1980a). Seed germination beneath parent plants was reported as being successful by Wright, if the seeds were depressed beneath the soils surface (FWS, 1990; Wright, 1989). No hybrids are currently known to occur with pondberry.

Habitat Requirements

13. Habitat requirements of pondberry appear to be highly variable across its range. In general, it occupies wetland habitats that are normally flooded or saturated during the dormant season, but infrequently flooded during the growing season for extended periods (Tucker, 1984). The specific habitat types occupied by pondberry have been variously described; e.g., "inhabits mesic to hydric sites (i.e., bottomland hardwoods, depressions, and margins of sandy sinks and ponds)" (Wofford, 1983) and "sandy sinks and pond margins, swamps and pond margins, and swampy depressions" (Porcher, 1980).

14. These habitat types vary from the edges of limestone sinks in South Carolina to depressions within bottom-land hardwoods in Mississippi. Although factors such as associate species and soils are variable across its range, the characteristic of occupying locally depressed or ponded areas is consistent throughout its range. This discussion concerning the Mississippi population is based on previously published data, as well as field surveys of the known colonies conducted in 1990 by the U.S. Army Corps of Engineers.

15. Tucker (1984) reported that pondberry populations in Mississippi are associated with ". . . mature bottomland hardwood forests in low depressions." Populations are currently known to exist in the Delta Region of west-central Mississippi. The habitat of pondberry here is similar to that in Arkansas and Missouri (FWS, 1990). The Corps (1991) reported that pondberry colonies in Mississippi are typically found on slight ridges in a ridge and swale community which is either frequently or periodically flooded or is in proximity to a permanent water body. The extant populations in Mississippi are all associated with bottom-land hardwoods at elevations where rainfall/local hydrology dominates the hydrologic conditions at the pondberry colony site.

16. The Mississippi populations are most frequently found on soils characterized by the Sharkey-Alligator-Dowling Association and less frequently on soils characterized as Alligator-Dowling-Forestdale Association as delineated by the Natural Resources Conservation Service (formerly the Soil Conservation Service) soil survey maps of Sharkey County, Mississippi. These soil associations are very similar, with both being found on level, poorly drained soils in slack-water areas and depressions. The Alligator-Dowling-Forestdale Association can also be found on old natural levees (Natural Resources Conservation Service, 1962). The soils within these associations all have poor drainage, high water table, low permeability rates, and gleyed Band C horizons (Tucker, 1984; Banker and Goetz, 1989). The tight clay subsoils of these associations result in slow permeability rates (0.2 to 0.6 inch per hour near surface and 0.06 inch per hour in subsoils). Therefore, overland sheet flow dominates water movement in these soils (Banker and Goetz, 1989).

17. The Corps (1991) reported that of 44 pondberry colonies surveyed, 41 percent were located in surface soils classified as silty clay, 32 percent is silty clay loams, and 21 percent in silt loam soils. This indicates that pondberry colonies will not likely be found on strictly heavy Alligator,

Sharkey, or Dowling clay soils. Extant pondberry colonies are found on soils with a mixture of heavy clays and lighter soils.

Associate Species

18. Common reports of associate species for Mississippi pondberry populations list only tree species such as Quercus spp., Celtis laevigata, Ulmus Americana, Fraxinus pennsylvania, Carya, etc. (Morgan, 1983; Tucker, 1984). The Corps (1991), through collection of field data from 44 colonies in Mississippi, was able to more clearly define associate tree and shrub species.

19. The most common overstory tree species, in descending order of frequency, that were reported from the Mississippi colonies include: oaks (Quercus phellos, Q. nuttallii, and Q. lyrata), sweetgum (Liquidambar styraciflua), and elms (Ulmus crassifolia, U. americana, and U. alata). The most frequent associate understory species are Liquidambar styraciflua and Celtis laevigata. Common species in the shrub layer, in descending order of frequency, include Styrax americana, Ilex deciduas, Celtis laevigata, Acer rubrum, Fraxinus pennsylvania, Ulmus spp., Cornus drummondii, Quercus spp., Sabal minor, Sambucus Canadensis, Diospyros virginiana, Morus rubra, and Liquidambar styraciflua.

Reasons for Decline

20. While there are no records in the literature of pondberry's status (whether it was abundant or scarce) before modern times, apparent reasons for the species current endangered status is discussed in the following paragraphs.

a. Alteration and loss of habitat.

(1) The most critical threat to pondberry, as with many endangered species, is the alternation/ modification and/or loss of habitat. Three factors which constitute this threat are certain timber harvesting practices, certain drainage activities, and land clearing operations for agricultural, commercial, and private development (FWS, 1990). Various problems are associated with timber harvesting activities such as heavy equipment crushing plants, felled trees crushing plants, or uprooting adjacent trees, opening closed or dense forest canopies, and possible changes in the hydrology. Kral (1983) reported that single-tree selection harvesting in hardwoods would likely not affect pondberry, while clear-cut harvesting, which would result in increased surface water runoff, could potentially increase floodwater levels to a detrimental degree. Within the Delta National Forest in Mississippi, the U.S. Forest Service, along with FWS, determined that a 100-foot undisturbed buffer around known pondberry colonies along with a 40-acre size limit on clear-cut openings would prevent any major changes in hydrology and maintain an adequate crown closure around a colony (Banker and Goetz, 1989).

(2) Several authors have made general statements about drainage activities and subsequent effects on pondberry such as ditching which could change the surface and/or ground-water regime in a manner that could reduce the plant's vigor or possibly eliminate it from an existing site (Kral, 1983; Wright, 1989; FWS, 1990). The general consensus appears to be that altering wetland habitat by changing water levels in an area is likely detrimental to the species. The Corps (1991) through extensive field studies of pondberry within Mississippi and consultation with various experts determined that only drainage activities which significantly alter the local hydrological regime of depressions, ponds, sinks, or other areas governed by localized hydrology would adversely affect pondberry colonies.

(3) The third factor associated with the loss of habitat is land clearing due to agricultural interests and other developments. Throughout pondberry's range, bottom-land hardwoods and similar habitat types have been extensively cleared. Within the Mississippi River alluvial valley, bottom-land hardwoods decreased 56 percent, from 11.8 million acres in 1937 to 5.2 million acres in 1978 while agricultural/croplands increased nearly 5 million acres during that same time period (FWS, 1979).

b. Disease/predation.

(1) The literature indicates that nearly all colonies of pondberry are affected by stem die-back. Rayner and Ferral (1988) reported that stem die-back and predation were two factors that lead to poor colony health in the Honey Hill region of South Carolina. Stem die-back has been hypothesized to be fungal and/or drought related, but could be characteristic of the species. Predation has been observed by deer and insects, mainly the spicebush swallowtail caterpillar (Rayner and Ferral, 1988; Corps, 1991). Field studies of pondberry colonies in Mississippi appear to indicate stem die-back and insect damage influence the general health of many colonies (Corps, 1991).

(2) Browsing by vertebrates appears to occur only occasionally. Some stems were reported to be eaten by rabbits during winter (Wright, 1989). The Corps (1991) reported evidence of herbivory at only one of 44 pondberry colonies in the Delta National Forest. A study on the Ecology and Reproductive Biology of Pondberry was done by the Center for Bottomland Hardwood Research in Stoneville, Mississippi. Three fungal pathogens from stems were isolated, and six insect species were found in association with pondberry. Neither the fungal pathogens nor insects appear to be a limiting factor for the plant (Devall and Boyette, unpublished).

c. Lack of reproduction. Most recent accounts and studies of pondberry list poor sexual reproductive success as another important reason in the decline of pondberry colonies. Many of the colonies studied in Mississippi consisted mainly of male plants. Some entire colonies contained only male stems. Consequently, colony expansion is suspected to occur primarily vegetatively. Sexual reproduction can be accomplished in a controlled environment (such as a nursery) as reported by FWS (1990), which indicated successful seed germination when seeds were depressed below the soil surface. During recent field surveys of the Mississippi population on Delta National Forest, numerous apparently viable seeds were observed on plants although no germination from the previous years fruits were observed. With the abundance of suitable habitat within the Delta National Forest, it is likely that if germination and sexual reproduction can occur in the wild, it could be occurring here. However, reports by Tucker (1984) and Morgan (1983) indicated that germination and new seedling establishment may not occur in the wild.

Additional Data

21. Pondberry Survey Methods and Results.

a. During the period September-October 1994, field surveys for pondberry were conducted. The survey included the entire direct rights-of-way for the project and a 5 percent survey (2,000 acres) of forested tracts, with a high potential for pondberry occurrence, south and west of the Delta National Forest. In addition to pondberry profile report information (Attachment 1), flood frequency data, and professional judgment was utilized to select forested tracts to survey. A summary of the transects surveyed for pondberry is presented in Table 14-1. Also, the Mississippi Natural Heritage Program (MNHP) was asked to review its records for reported pondberry colonies within the Yazoo Backwater Project Area from 1996 to 1999. The Corps of Engineers conducted additional field surveys for pondberry during the months of May-June 2000. The areas that were surveyed included Delta National Forest in Sharkey County, Mississippi, several parcels of private land located in Bolivar County, and a 32-acre plot located south of the Delta National Forest. From the data that were collected, there appeared to be no correlation between flood frequency and colony characteristics (see Attachment 2).

TABLE 14-1
SUMMARY
TRANSECTS SURVEYED FOR PONDBERRY
YAZOO BACKWATER STUDY

Transect Description	Quad (1:62,500)
Twin Oaks 01 and 01A	Lorenzen
Twin Oaks 02	Lorenzen
Twin Oaks 03	Lorenzen
Mahannah 01	Vicksburg
Mahannah 02	Onward
Mahannah 03	Onward
Mahannah 04	Onward
Mahannah 05	Onward
Reach 1, Tract 4	Talla Bena
Reach 1, Tract 9	Alsatia
Reach 1, Tract 43	Onward
Reach 1, Tract 16	Onward
Reach 1, Tract 25	Onward
Reach 1, Tract 59	Lake Providence
Reach 2, Tract 6	Onward
Reach 2, Tract 11	Lorenzen
Reach 2, Tract 14	Lorenzen
Reach 2, Tract 4	Onward
Reach 2, Tract 18	Lorenzen
Reach 2, Tract 23	Lorenzen
Reach 2, Tract 25	Onward
Reach 2, Tract 47	Auter
Reach 2, Tract 32	Swan Lake
Reach 4, Tract 28	Auter
Reach 4, Tract 25	Bayland
Reach 4, Tract 78	Auter
Reach 4, Tract 3, Transect A	Bayland
Reach 4, Tract 3, Transect B	Bayland
Reach 4, Tract 1	Bayland

b. No pondberry colonies or evidence of pondberry presence was noted within either the rights-of-way or the 2,000 acres surveyed in 1994. In a 31 January 2000 letter with an accompanying site map, MNHP noted 22 sites where pondberry colonies are established within the proposed project area. No sites were located in areas of direct impact.

c. Two colonies were discovered during surveys for two previous Yazoo Basin studies--Upper Yazoo Projects and Mississippi Delta. A colony containing six stems was located in Tallahatchie County, Mississippi, during the Upper Yazoo Projects, and a colony containing hundreds of stems was located in Bolivar County, Mississippi, during the Mississippi Delta study. Both colonies were at elevations at or greater than the 100-year frequency flood.

Evaluation of Potential Impacts

22. Implementation of the recommended plan would impose no direct impacts on the pondberry plant since no pondberry plants were observed within the construction rights-of-way.

23. Land clearing and the practice of clear-cut timber harvesting pose the greatest potential threat to the endangered pondberry. The recommended plan would not induce land clearing or contribute to promoting timber practices detrimental to the pondberry. Previous field surveys and consultation with experts (Corps, 1991) indicate that local hydrology is more important to the growth and health of pondberry than overbank flooding. Only those drainage activities which significantly alter the local hydrological regime of depressions, ponds, sinks, or other areas governed by localized hydrology would affect pondberry colonies. Implementation of the recommended plan would not alter the hydrological regime of ponds, sinks, or other areas governed by local hydrology. Additionally, the reforestation via conservation easements on 62,500 acres of open land below the proposed pump elevation would beneficially impact the endangered pondberry by reestablishing the dominant habitat association for pondberry populations in Mississippi.

24. Implementation of the recommended plan is not likely to adversely impact the endangered pondberry plant. This conclusion was reached after a review of appropriate literature and scientific data, and the negative results of a field survey for the pondberry plant.

LOUISIANA BLACK BEAR

Description

25. The Louisiana black bear was listed as a Federally threatened species on 7 January 1992 (57:588-595). The Louisiana black bear is one of 16 recognized subspecies of the American black bear Ursus americanus. Other free-ranging bears of the species Ursus americanus within the same range of the Louisiana black bear have also been designated as threatened due to similarity of appearance. Black bears in the region are normally black with a brown muzzle and an occasional white blaze on the chest (Black Bear Conservation Committee, 1992). The Louisiana black bear is distinguished from other black bears by possessing a skull that is longer, more narrow, and flat, and possessing proportionately large molar teeth (Nowak, 1986). While size varies depending on the quality and quantity of available food, large males may weigh more than 600 pounds.

Range and Population Level

26. The American black bear was formerly widespread in North America, from northern Alaska and Canada, including Newfoundland, south to central northern Mexico (Lowery, 1974). The Louisiana black bear, subspecies of the American black bear, historically occurred in

bottom-land forests from eastern Texas through all of Louisiana to southern Mississippi (Hall, 1981). Today, the black bear population is estimated to be less than 500 individuals (Black Bear Management Handbook, 1996).

Life History

27. Although classified as carnivorous, black bears are opportunistic omnivores since their diet is largely determined by food availability. Black bears spend considerable amounts of time foraging for food. The types of plants eaten vary with the season. Plants that bears may consume during spring and summer months include dewberries, blackberries, wild grapes, soft mast-producing shrubs, persimmons, and pokeweed. In the fall, acorns, pecans, corn, oats, and wheat may be consumed. Animal matter that black bears may consume include invertebrates and carrion.

28. The movement of bears and establishment of their home range are determined by food, water, cover, denning sites, and contact with potential mates. Adult males generally have ranges 3 to 8 times larger than adult females. Home range shape appears to be influenced by available forest cover (Marchinton, 1995). In a movement ecology study completed in fragmented bottom-land hardwood habitat, Marchinton (1995) found mean home ranges of 20.20 square miles and 4.87 square miles for males and females, respectively. Corridors providing cover may facilitate the movement by bears between highly fragmented forest habitats (Pelton, 1982; Norr, 1987).

29. The reproductive biology of the Louisiana black bear is not well-known. Most reproductive characteristics of the bear are assumptions based upon studies of black bears elsewhere. Mating generally occurs in the summer months. After a gestation period of 7 to 8 months, the cubs are

born in winter dens in January and February. Litter sizes in the Tensas River Basin range from one to three. Cubs emerge from the den with their mother in the spring and stay with her throughout the year suckling and later, eating solid foods. They den with her the following winter, emerge with her again in the spring, and live with her until the summer when the family unit dissolves.

30. Black bears use hollow trees, brush piles, and ground nests for winter dens. Adult males and subadults use ground dens with greater frequencies than adult females. Weaver and Pelton (1994) found that bears using ground nests and brush pile dens appeared to be more vulnerable to human disturbance than those in tree dens. Tree dens may also be an important component for female reproductive success, especially in areas subject to flooding (Smith, 1985).

31. Black bears may live over 25 years in the wild. The most important natural factor regulating black bear populations appears to be variation in food supply and its effect on physiological status and reproduction (Rogers, 1976).

Reasons for Decline

32. Black bears are primarily animals of heavily wooded areas. Destruction or modification of bottom-land hardwood habitat represents the most significant threat to the Louisiana black bear. In addition, habitat fragmentation has limited the potential for the present population to expand its current range.

Evaluation of Potential Impacts

33. The MNHP in a 31 January 2000 letter with an accompanying site map reported the occurrence/sighting of black bear at seven locations within the overall project area. Black bears

are primarily animals of heavily wooded areas. Direct impacts associated with project implementation would occur at the construction site, which consists of 110.5 acres of open land, 38 acres of woods, and 5.2 acres of water. The wooded portion of the proposed construction site was surveyed for signs of bear activities in February 2000 by Corps biologists. No evidence of bear activity; e.g., scratch marks on trees or suitable denning sites, was observed. Thus, construction associated with implementation of the recommended plan would not likely impact the Louisiana black bear. Integral to the proposed project is the reestablishment of bottom-land hardwoods via conservation easements on 62,500 acres of open land below the pump elevation. This feature would significantly complement the FWS Recovery Plan for the Louisiana black bear by (a) reestablishing habitat highly suited to the black bear and (b) providing additional cover to facilitate the movement of bears between the highly fragmented forest habitats of the Mississippi River Delta.

34. The proposed project is not likely to adversely impact the Louisiana black bear.

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ATTACHMENT 1

PONDBERRY PROFILE

FINAL REPORT

PONDBERRY PROFILE

ENDANGERED SPECIES STUDY

CONTRACT NO. DACW38-90-D-0003

DELIVERY ORDER NO. 12

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS

VICKSBURG DISTRICT
P. O. BOX 60
VICKSBURG, MISSISSIPPI 39181

PREPARED BY:

GEO-MARINE, INC.

PLANO, TEXAS AND BATON ROUGE, LOUISIANA

APRIL, 1991

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PONDBERRY PROFILE

I. INTRODUCTION

This report discusses the methods and findings of the Pondberry Profile Endangered Species Study undertaken by Geo-Marine, Inc. (GMI). This report was prepared for the U.S. Army Corps of Engineers, Vicksburg District, under Contract No. DACW38-90-D-0003, Delivery Order No. 012.

Descriptions of the general project background as well as the purpose of this study are given in this section of the report. Methods adopted and utilized during the investigation are discussed in Section II. Results of the Pondberry Profile Study are addressed in Section III while Section IV presents the study's conclusions and recommendations.

PROJECT BACKGROUND AND PURPOSE

The U.S. Army Corps of Engineers, Vicksburg District, is currently undertaking a comprehensive reformulation study of the Upper Yazoo and Steele Bayou flood control projects. These projects involve various structural measures such as levee construction and channel modifications. The purpose of these measures is to reduce the area inundated by flooding. As part of the reformulation process, the Vicksburg District is analyzing all potential environmental effects, both adverse and beneficial, that are expected with each of the alternative flood control measures.

One of the potential effects is associated with the endangered plant species, pondberry (Lindera melissifolia). The U.S. Fish and Wildlife Service (USFWS) listed the pondberry as endangered on 31 July 1986. Since there are known pondberry locations within the Mississippi Delta Region (ie. Delta National Forest), a potential

exists for proposed flood control measures to affect (adversely or beneficially) extant pondberry communities.

Therefore, the Vicksburg District, in an effort to allow an accurate assessment of potential effects, has engaged in this pondberry profile study. The overall goal of this project was to develop a profile of the pondberry's life requisites within Mississippi. The profile was to be developed through field data collected and analyzed from known pondberry colonies and from pertinent secondary sources. The profile could then be used to develop a stratified sampling scheme which could be applied to the Upper Yazoo and Steele Bayou basins.

II. METHODOLOGY

The procedures implemented in developing the pondberry profile can be grouped into three categories: 1) literature search and review, 2) expert consultation, and 3) field data collection and analysis. This section discusses the methods and procedures utilized in each category.

LITERATURE SEARCH AND REVIEW

GMI's literature search included a review of both published and unpublished documents which evaluate and describe pertinent data and known facts about pondberry. GMI's sources of published and unpublished literature included botanical and biological abstracts, university herbariums and their literature collections, the Mississippi Natural Heritage Program, the USFWS, personal consultation with university professors and the U.S. Army Corps of Engineers, Vicksburg District.

In order to obtain a broad understanding of pondberry, a wide array of information was sought such as known colony sites, associated vegetation, morphological characteristics, reproductive characteristics, associated habitats and other apparent life requisites.

An annotated bibliography of the documents reviewed is included in this report as Appendix A.

EXPERT CONSULTATION

In order to verify/refute information obtained from the literature review and to obtain additional unpublished information, persons expected to have extensive experience or interest in pondberry were consulted. Initial contact and subsequent consultation were made by telephone conversation. A list of names,

telephone numbers, and addresses of those persons found to have a keen interest and/or knowledge of pondberry was then developed.

These people were consulted prior to initiating field work for help in developing the field data sheet. In addition, the experts were invited to a workshop, conducted at the Vicksburg District, to provide a critical review of the profile developed by GMI and to form a consensus concerning potential impacts and sampling schemes for subsequent surveys. The workshop is discussed in further detail in Section IV.

FIELD DATA COLLECTION AND ANALYSIS

GMI, along with the Vicksburg District, determined that in addition to literature review and expert consultation, prudent and worthwhile methods of developing a profile of pondberry should involve an analysis of extant pondberry colonies within the Delta region of West-Central Mississippi. Numerous known colonies are found on the Delta Natural Forest (DNF) and on private lands in Bolivar and Sunflower counties, Mississippi north of the DNF.

Before attempting any fieldwork, GMI developed a list of various biological and ecological factors relevant to pondberry that could be evaluated either objectively or subjectively in the field. This list of parameters was developed through the aid of the Vicksburg District, information gleaned from the literature review, and from advice and suggestions obtained through expert consultation. After compiling an appropriate list of relevant biological and ecological factors, a field data form was developed to better facilitate data collection (Exhibit A).

As previously mentioned, data were collected from existing pondberry colonies within the DNF and on private lands in Bolivar and Sunflower counties, Mississippi. A team of three people

GEO-MARINE, INC.
PONDBERRY PROFILE FIELD DATA

Recorder:_____ Sampler(s):_____ Date:_____
Location:_____ Colony ID : _____ Plot Number: _____
_____

Plot radius = 37 ft. (0.1 acre)

GENERAL QUESTIONS

What is the distance (ft.) to the nearest body of water? . _____
(Measure in field or determine from map)

What is the relative elevation of plot center? . . . . . _____

What is the maximum water depth on the plot? . . . . . _____

What general soil type is present? . . . . . _____

What is the soil pH? . . . . . _____

Stand Maturity, most trees are (circle one). 6" DBH 6-18" DBH >18" DBH Mixed Sizes

Is there any evidence of past disturbance near the site? . . . Yes
(e.g. stumps from harvesting operations, beaver damage, etc.) No

ASSOCIATED VEGETATION

Percent Canopy Coverage (Using densiometer)
North reading_____East reading_____South reading_____West reading_____
Avg. Percent Canopy Cover _____

Overstory Species

Understory Species

Shrubs and Herbaceous Species

PONDBERRY COLONY DATA

Number of clumps . . . . . _____
Avg. number of stems within each clump . . . . . _____
Approximate total number of stems . . . . . _____
Number of female stems . . . . . _____
Average height of clumps (ft) . . . . . _____
Average groundline diameter of stems . . . . . _____
Apparent health of colony . . . . . excellent good fair poor

including an ecologist, forester, and biologist performed the data collection. Compartment maps supplied by the Forest Service and topographic maps supplied by the Mississippi Chapter of The Nature Conservancy delineating known pondberry colonies were used to facilitate colony location in the field. Because many of the colonies are in remote areas, the field team was required to conduct transects in the general vicinity in order to locate the colonies. Each colony located was thoroughly sampled by completing the field data form, given a colony ID number, and then properly mapped, if not done so, on the reference maps.

Soil samples were collected at each site (Photograph 1) and submitted to the Louisiana State University Soils Testing Laboratory (Baton Rouge) for analysis. Each soil sample was analyzed for pH, phosphorus, sodium, potassium, magnesium, calcium, percent organic matter and characterized for physical attributes (ie. silt, loam, clay, etc.)

Elevations and distance were measured using a combination of pacing, topographic map interpretation, and visual estimations. Where the latter was utilized, consensus among the field team members was required.

Canopy cover was measured with a densiometer near the center of each pondberry colony. Associate species were recorded within a 0.1 acre plot surrounding the colony center at each vegetational layer (i.e., overstory, understory, shrubs and ground cover).

With the exception of a few very large colonies, individual stems of each clump of pondberry were counted and recorded. Stems were considered an individual plant if there was no apparent connection to other stems at or near the ground surface. For this study, clumps were defined as groups of stems that were located at least 15 feet from each other.

Photograph 1. Soil sampling at pondberry colonies.

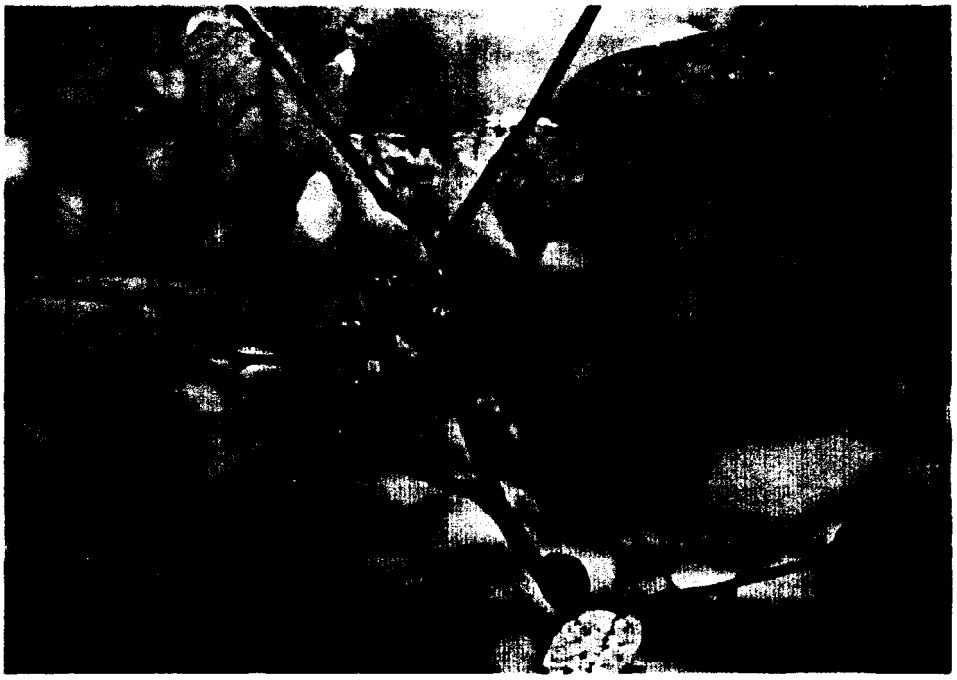
For large colonies, such as the one in the Dowling Bayou Greentree Reservoir, a 25 percent sample of the colony was counted, measured and recorded. The numbers were then extrapolated for the entire colony. However, each female stem was counted and recorded, regardless of the size of the colony. Female stems were identified by maturing fruit (Photograph 2) and/or fruit pedicels from 1990 and 1989.

The general health of the colony was a subjective value based upon the ratio of dying stems to live stems, physical appearance of the leaves and stems, the density of the colony and the magnitude of insect damage (Photograph 3).

Pertinent quantitive field data were compiled from the field data sheets and statistically analyzed using the PARADOX$_{TM}$ computer software program. The analyses performed included means and standard deviation values of each parameter as well as pair-wise correlations for all variables.

Because herbaceous species are seasonal and are not possible to accurately identify in bottomland hardwood communities using remote sensing techniques, they would lack relative importance to developing a stratified sampling scheme. Consequently, herbaceous species were not included in the statistical analysis. Similarly, most of the woody vines, such as poison ivy (Rhus radicans), trumpet creeper (Campsis radicans), and grape (Vitus spp.) were not included in the statistical analysis because of their cosmopolitan habitat requirements.

Photograph 2. Pondberry fruit.



Photograph 3. Spicebush swallowtail caterpillar (Pterourus troilus) on pondberry.

III. RESULTS OF PONDBERRY PROFILE

This section details the findings of the Pondberry Profile Endangered Species Study. The results are presented in three subsections:

1) General
2) Physical Data
3) Biological Data

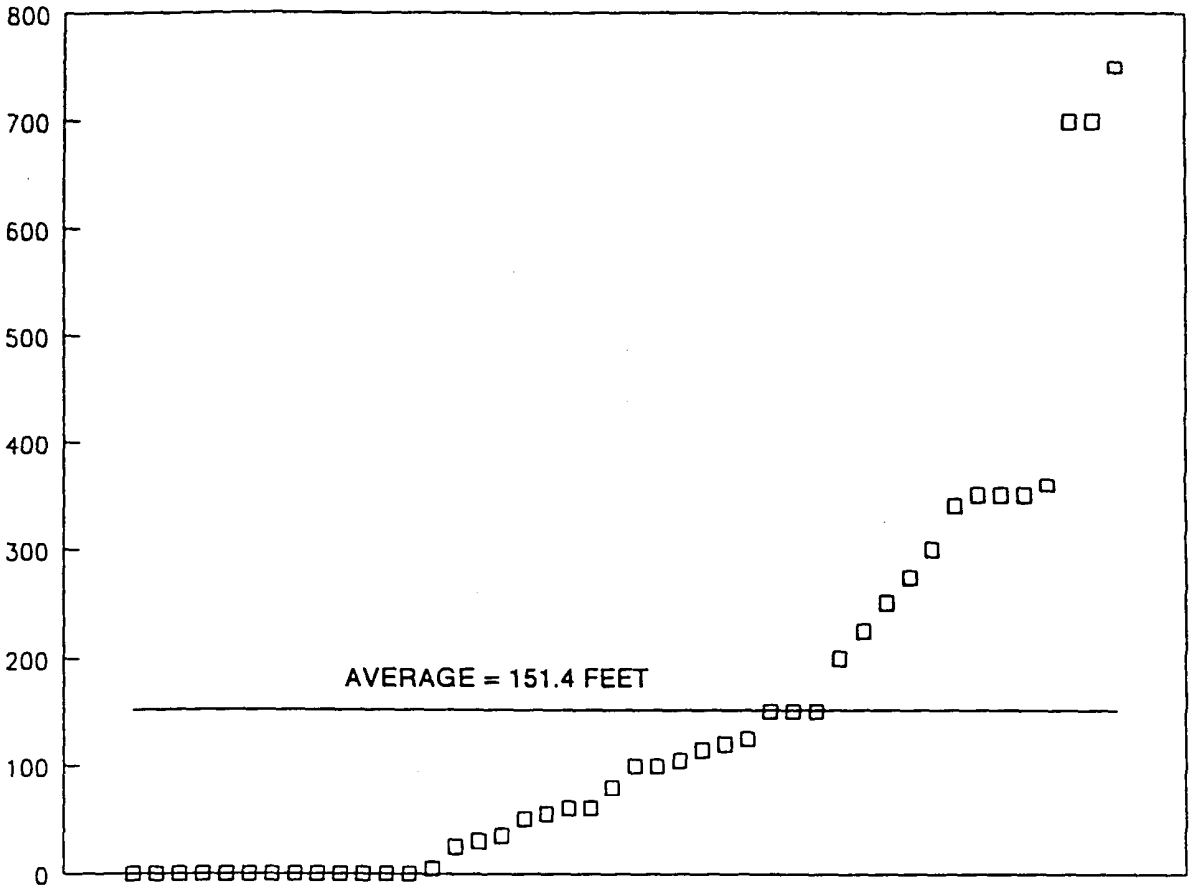
GENERAL

A total of 44 pondberry colonies were visited, only three of which were not located in the DNF. These three colonies were on private lands that supported small (less than five acres) remnant bottomland hardwood communities surrounded by croplands, primarily cotton and soybeans. The DNF is comprised of bottomland hardwoods with isolated and limited stands of cypress/tupelogum swamps.

PHYSICAL DATA

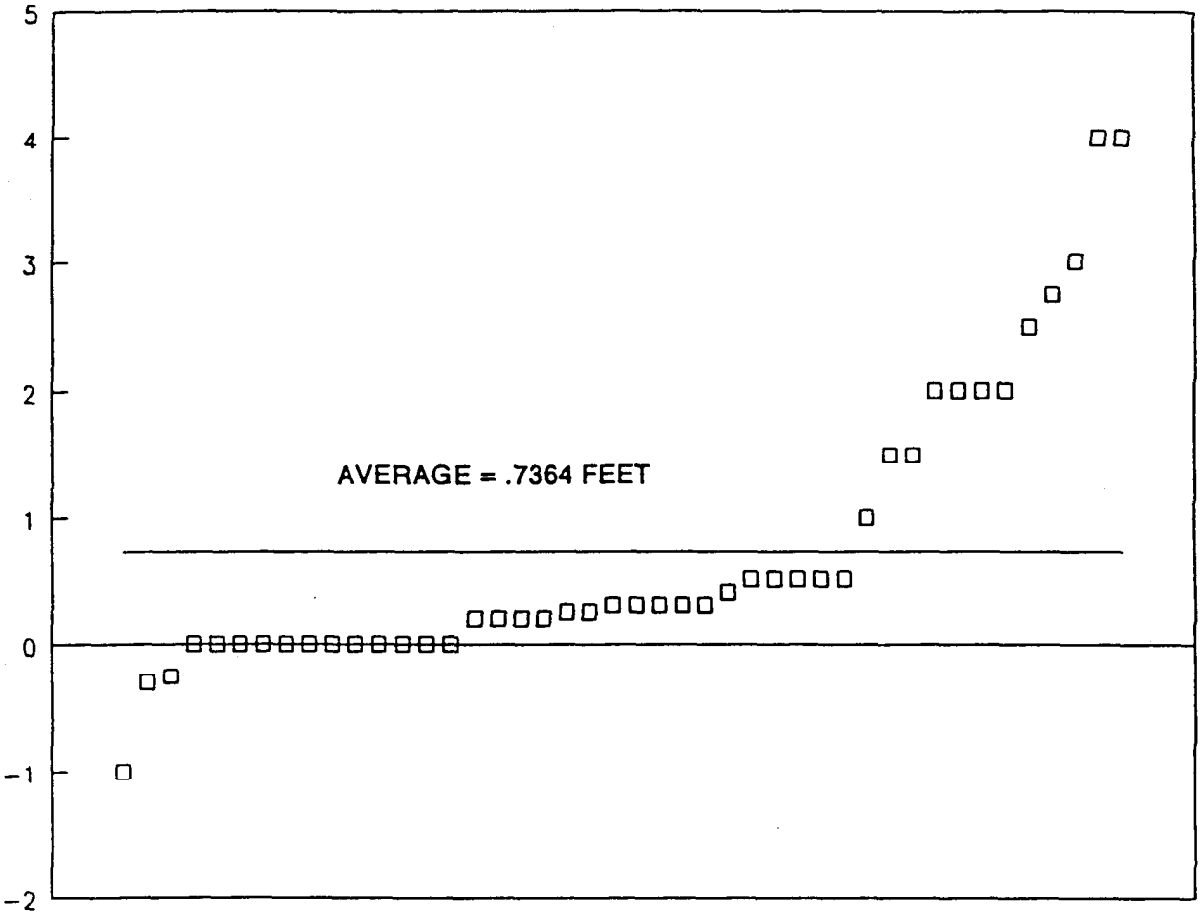
The average distance of a colony from a "permanent" or standing body of water was 151.4 feet. This distance is skewed due to three colonies which were in excess of 700 feet from a waterbody. Without these three colonies, the average distance would be 110 feet. Of the 44 colonies, 14 (32 percent) were within five feet of a waterbody. Figure 1 illustrates the distribution of each colony relative to its proximity to waterbodies.

The average elevation of the colonies, relative to the surrounding land, was 0.7 feet higher (Figure 2). Twelve colonies (27 percent) were in areas with no immediate topographic relief. Three colonies were in a slight depression area ranging from three to 12 inches lower than the surrounding land. Contrarily, nine colonies were on knolls/ridges that were two to four feet higher than the surrounding lands.



Source: GMI

Figure 1. Distance between pondberry colony and waterbody (in feet).



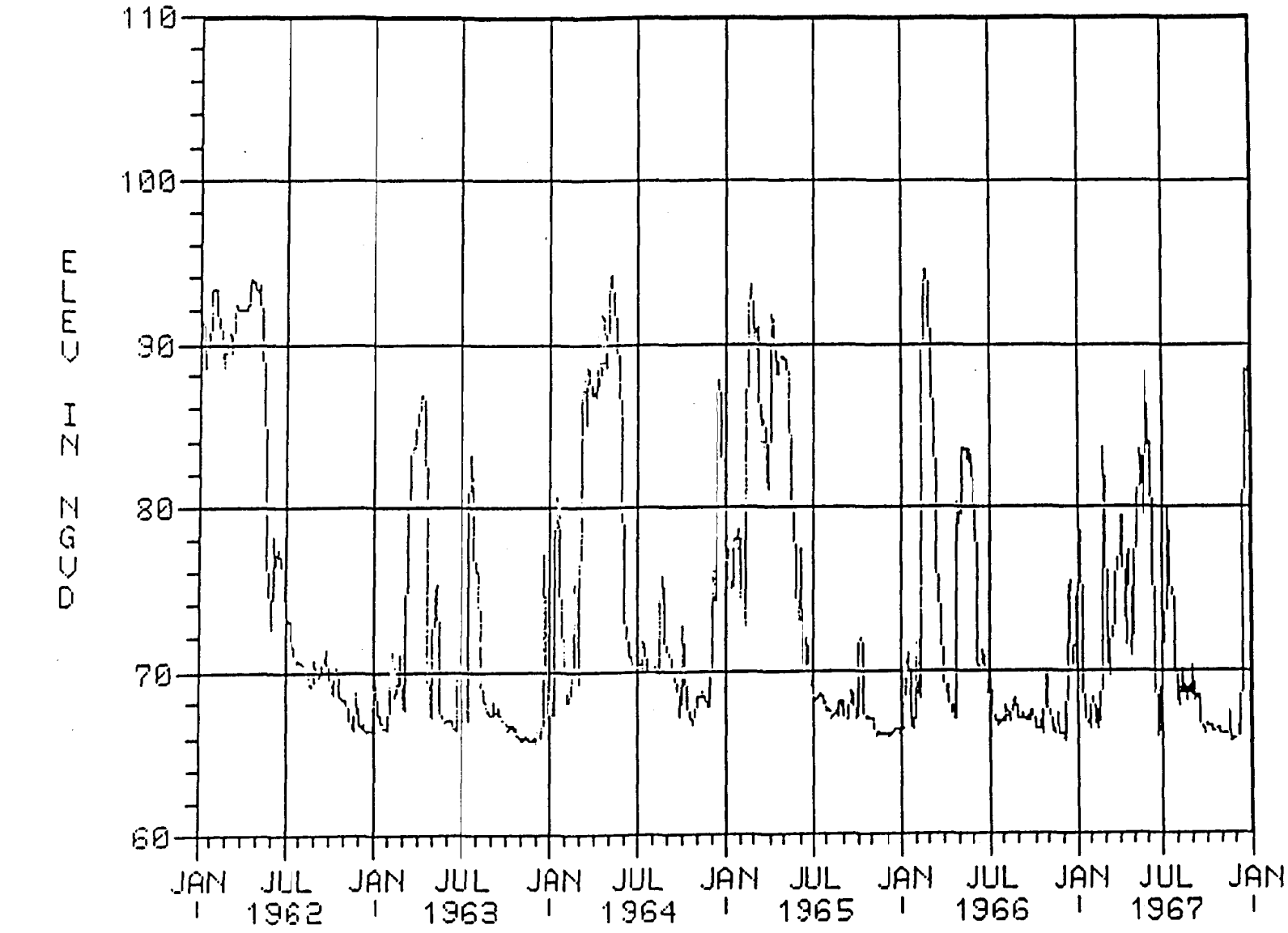
Source: GMI

Figure 2. Relative elevation of plot center for surrounding lands (in feet).

The approximate elevations of the 44 colonies sampled ranged from 91 to 145 feet National Geodetic Vertical Datum (NGVD). The elevation of the 39 colonies sampled on DNF ranged from 91 to 98 feet NGVD, with the average elevation of these colonies at 95.2 feet NGVD. Of the 39 colonies on DNF, 34 colonies (87 percent) were at elevations at or greater than 94 feet NGVD. This average elevation indicates that these colonies are above the 15-20 year floodplain of the Big Sunflower River, the main drainage system of the DNF. Water elevations on the Big Sunflower River for the period 1962-1990 are presented on Figure 3. As can be seen from this figure, river stages greater than 94 feet occurred only five times during the past 30 years and for very short durations during each occurrence.

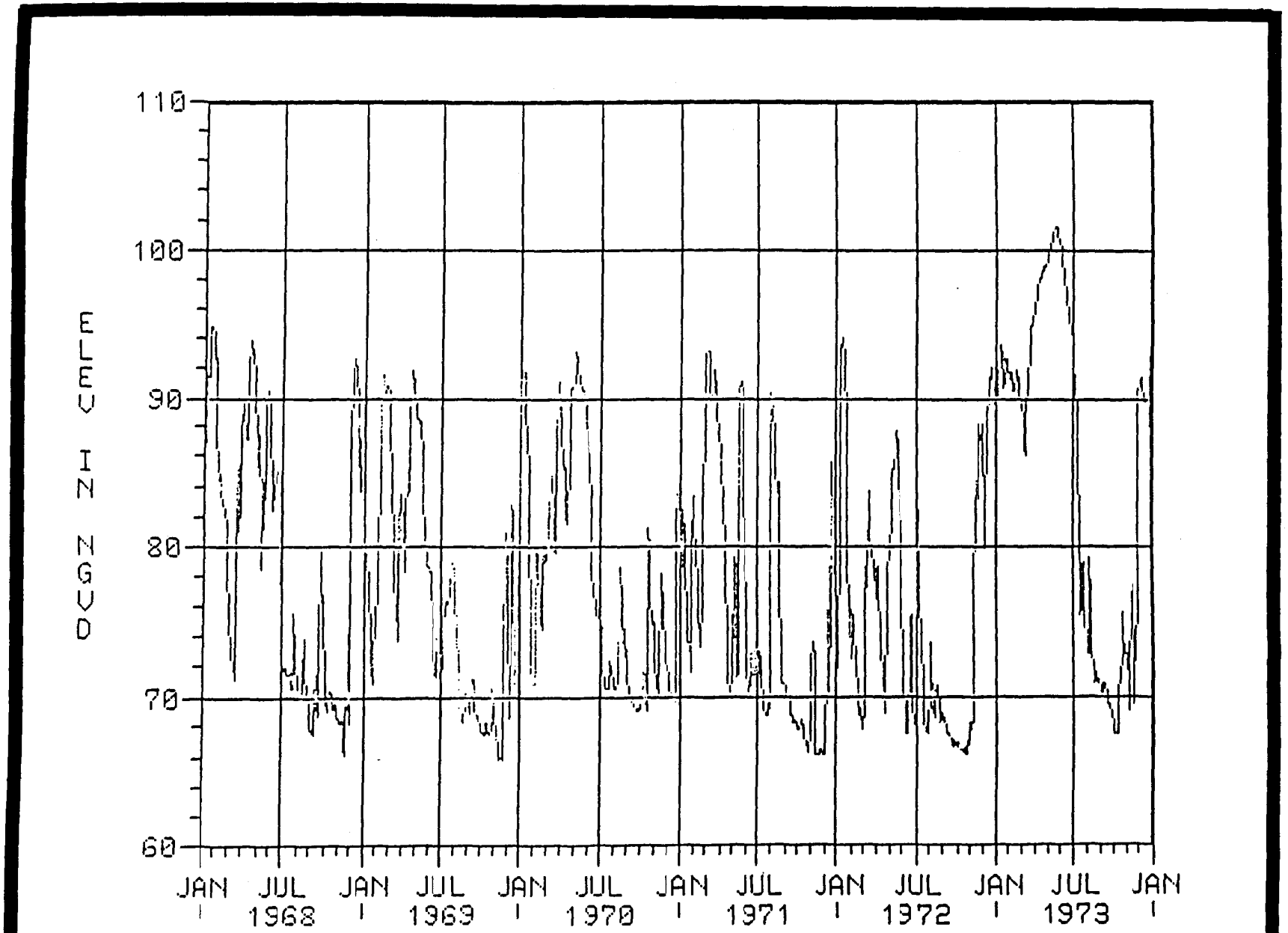
Although the majority of the colonies were in proximity to standing water and in relatively flat areas, 32 of the 44 colonies (73 percent) had no indication of standing water within the colony. The remaining 12 colonies had evidence of standing water ranging in depth from 1.5 to six inches (Figure 4).

Silt comprised a major portion of the soils at all the colony sites. Approximately 41 percent of the colonies were located in soils classified as silty clay and about 32 percent were situated in silty clay loam soils. The remaining 27 percent of the colonies were located in silt loam soils. A summary of the results of the soil chemical analyses of the 44 soil samples collected is presented in (Table 1).



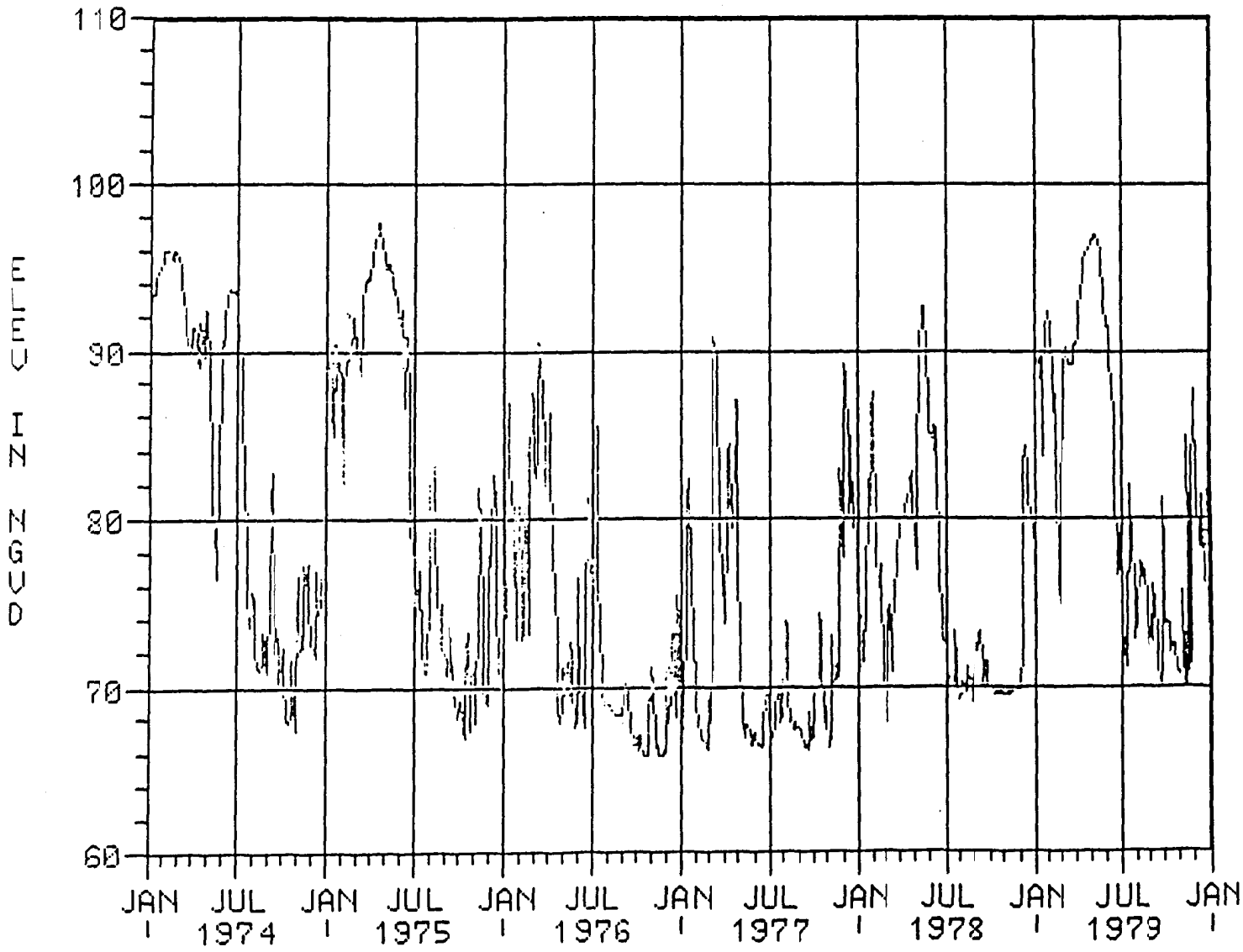
Source: U.S. Army Corps of Engineers, Vicksburg District.

Figure 3. River stages on Big Sunflower River at Holly Bluff



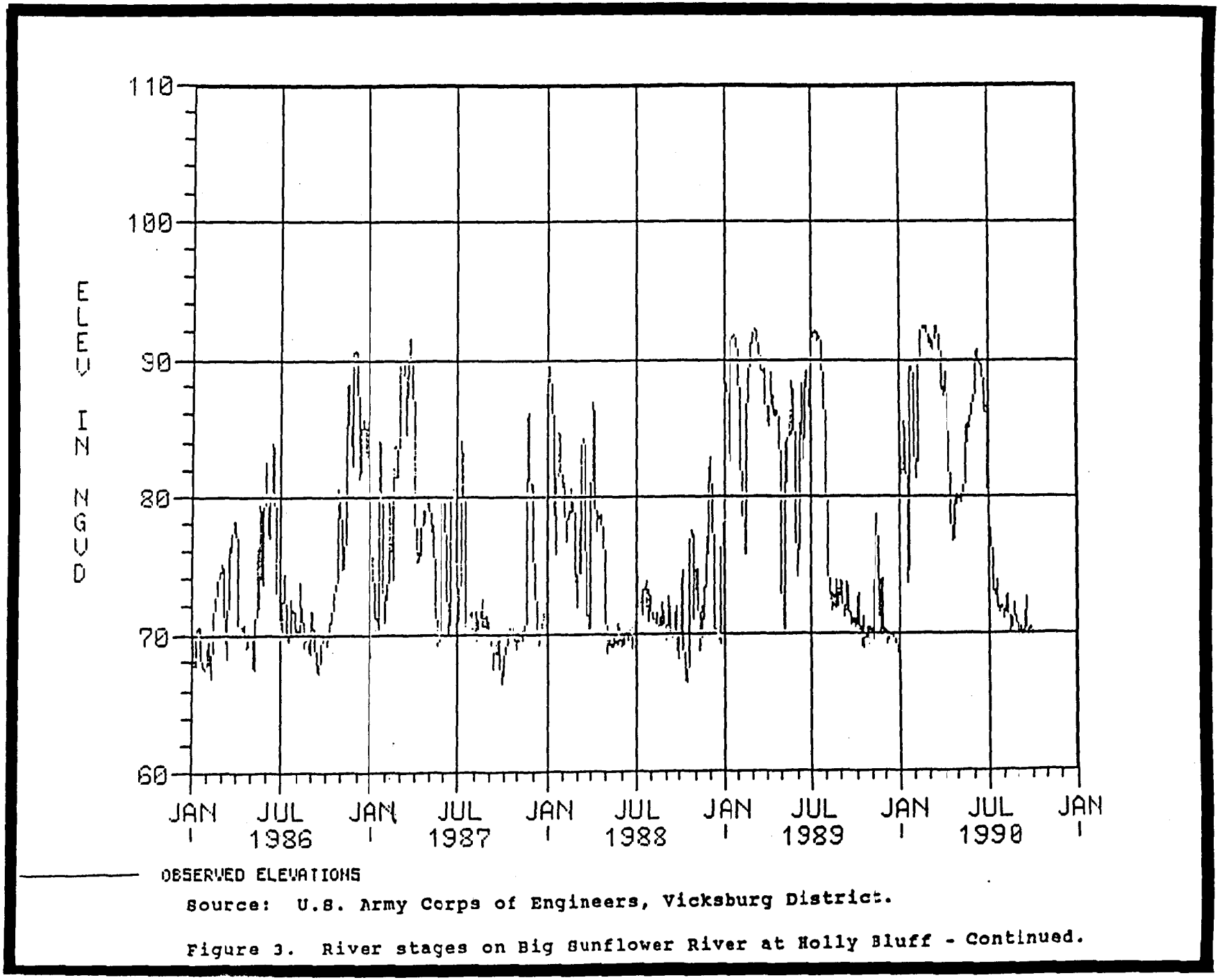
Source: U.S. Army Corps of Engineers, Vicksburg District.

Figure 3. River stages on Big Sunflower River at Holly Bluff - Continued.



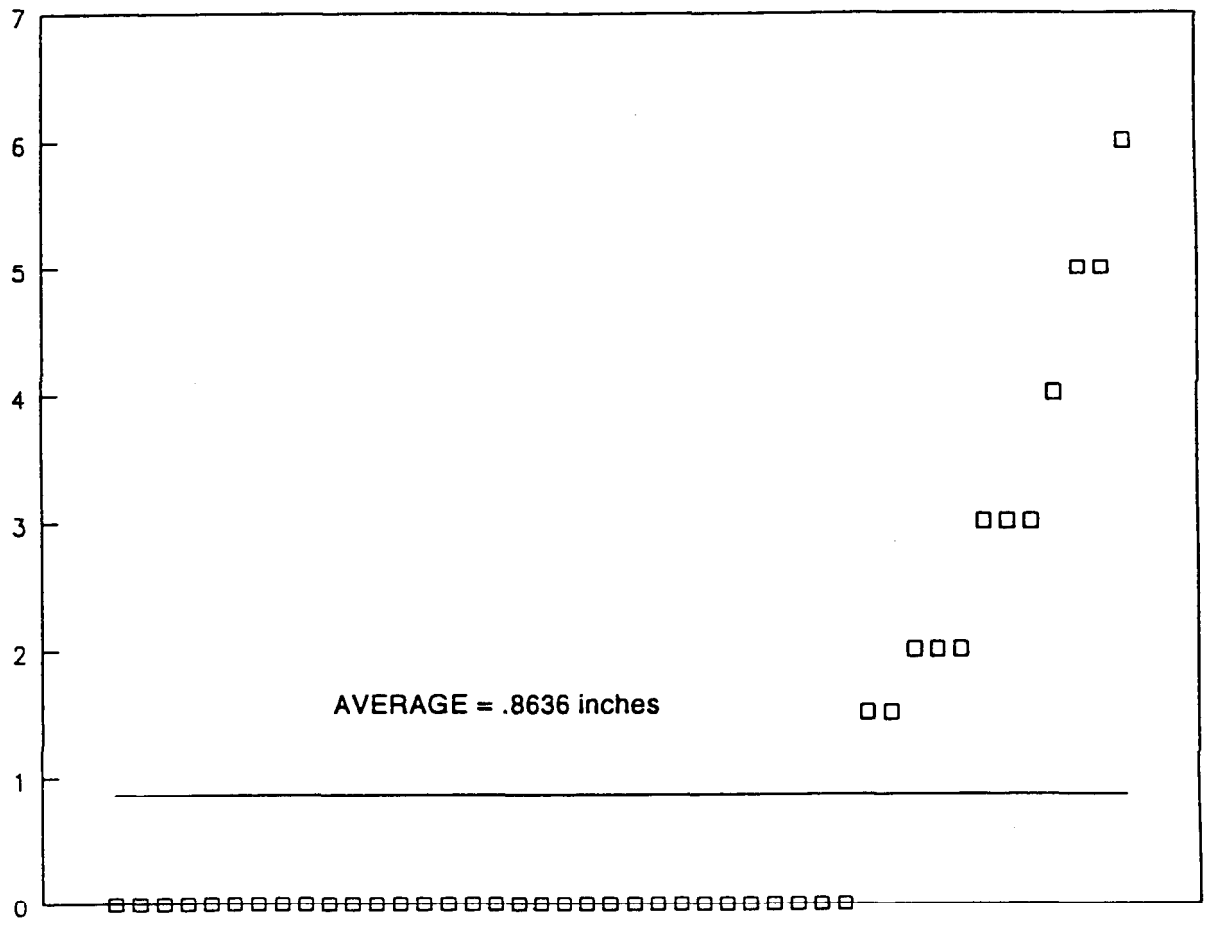
Source: U.S. Army Corps of Engineers, Vicksburg District.

Figure 3. River stages on Big Sunflower River at Holly Bluff -Continued.



Source: U.S. Army Corps of Engineers, Vicksburg District.

Figure 3. River stages on Big Sunflower River at Holly Bluff - Continued.



Source: GMI

Figure 4. Maximum depth water on plots (in inches).

TABLE 1

Analytical Results of Soil Samples Collected at
44 Pondberry Colonies, Mississippi

	Minimum Value	Maximum Value	Average
pH	4.7	5.7	5.1
Phosphorous	38.0	359.0	129.2
Sodium	13.0	58.0	30.2
Potassium	98.0	600.0	278.4
Magnesium	334.0	1493.0	698.6
Calcium	1319.0	5228.0	2879.7
Organic matter (%)	0.6	4.5	1.8

Note: Unless otherwise specified, all units are in parts per million (ppm); pH has no units.

Source: GMI

BIOLOGICAL DATA

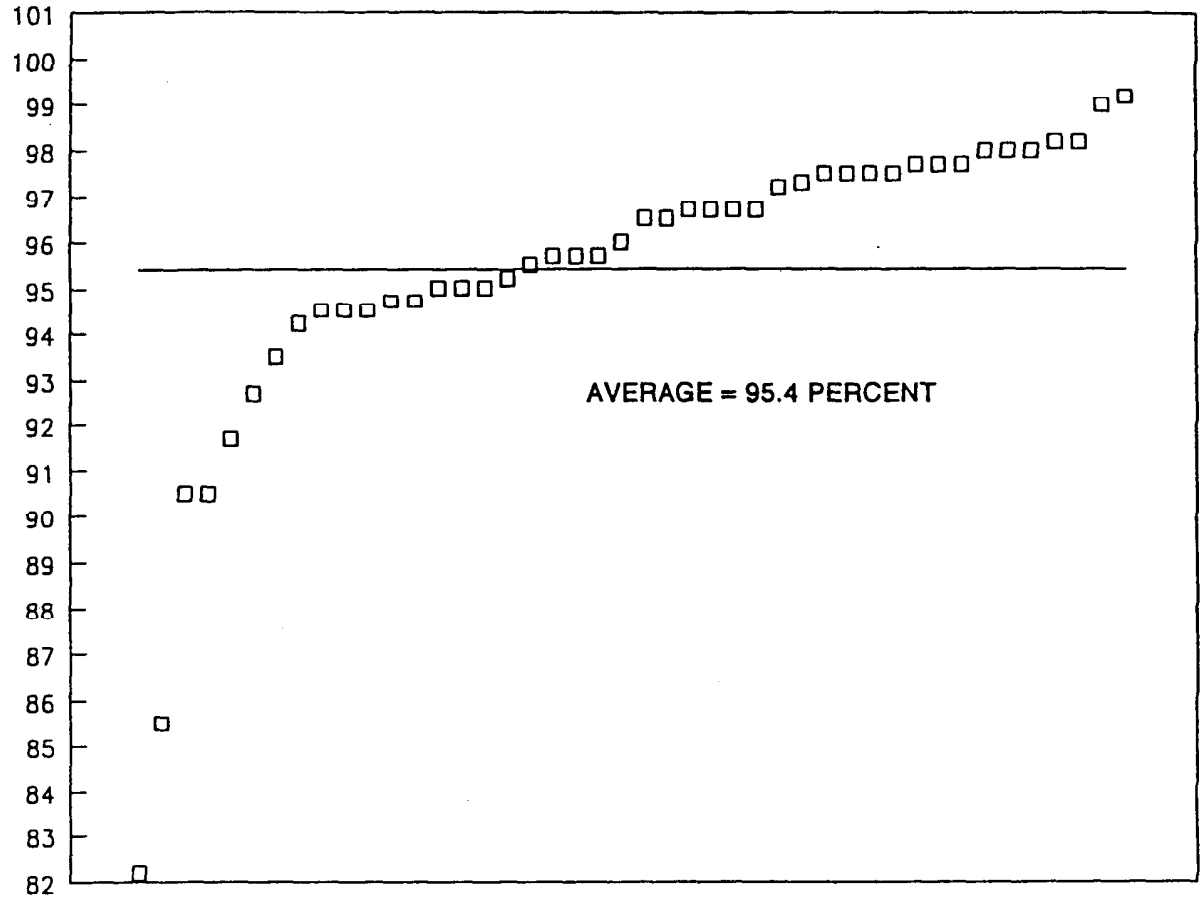
The average percent canopy closure was 95.4, which is generally indicative of a mature forest stand with a multi-layered canopy (Photograph 4). The lowest canopy closure recorded was 82 percent, which occurred at one of the sites located on private lands that was completely surrounded by croplands. Only seven colonies were located in stands with canopy closures of less than 94 percent (Figure 5).

Oaks, primarily Quercus lyrata, Q. phellos, and Q. nuttallii, were the most frequently recorded overstory species occurring at 82 percent of the colony sites. Sweetgum (Liquidambar styraciflua) and elms (Ulmus americana, U. alata, and U. crassifolia) were recorded in the overstory of about 60 percent and 50 percent of the sites, respectively.

Sweetgum and sugarberry (Celtis laevigata) were the most common understory species, occurring in 70 and 57 percent of the sites, respectively. The most common shrub species were American snowbell (Styrax americana) and deciduous holly (Ilex decidua), both of which occurred in over 82 percent of the sites. Other common shrub species, in descending order of frequency, include: sugarberry, red maple (Acer rubrum), green ash (Fraxinus pennsylvanica), elms, swamp dogwood (Cornus drummondii), oaks, palmetto (Sabal minor), elderberry (Sambucus canadensis), persimmon (Diospyros virginiana), red mulberry (Morus rubra), and sweetgum.

Oaks were recorded within either the overstory, understory, or shrub layer in all of the sites. The other species that were most frequently recorded in at least one of the vegetation layers included elm (98 percent), sugarberry (86 percent), green ash (84 percent), and sweetgum (82 percent). The strongest correlation between any two of the species occurring at a given site was with sweetgum and palmetto.

Photograph 4. Pondberry colony under dense BLH canopy.



Source: GMI

Figure 5. Average percent canopy cover.

IV. CONCLUSIONS AND RECOMMENDATIONS

This section discusses the conclusions, based upon the results of GMI's field investigations, of a typical pondberry colony in Mississippi. This profile was presented to and reviewed by several known pondberry experts during a workshop conducted at the Vicksburg District, as will also be discussed later in this section. Recommendations for subsequent investigations and potential mitigation measures are presented in the last part of this section.

PROFILE OF A TYPICAL PONDBERRY COLONY IN MISSISSIPPI

Based upon physical and biological data, it appears that the typical pondberry colony within Mississippi should occur on slight ridges in a ridge and swale community which is either frequently or periodically flooded (Photograph 5), or is in proximity (less than 100 feet) to a permanent waterbody, with soils that are comprised of silty clays, silty loams, or a combination of the two. The pondberry populations in Mississippi are shade tolerant and probably shade dependent. Common associate tree species are oaks, sweetgum, and elms, while common associate shrub species are American snowbell, deciduous holly and palmetto.

However, it should be noted that because the majority of the colonies are located on the Delta National Forest and the Forest Service manages for oaks, the apparent importance of oaks as associate species may be exaggerated. It should also be noted that, although cypress (Taxodium distichum and/or T. ascendens) has been reported from various locales as a common associate, the closest cypress tree to any of the pondberry sites visited was 50 feet and the majority of the sites (86 percent) were beyond 200 feet from the nearest cypress tree. Further, the cypress trees recorded within 200 feet of the pondberry colonies were usually individual or sporadically located trees that did not comprise a cypress community.

Photograph 5. Typical pondberry colony on relatively flat terrain with slight ridge and swales.

(Note the absence of ground cover in the foreground indicating long periods of standing water.)

Pondberry colonies in Mississippi are located at elevations above the 15-20 year floodplain of the Big Sunflower River. River stages of the Big Sunflower River at Holly Bluff, Mississippi, and the average elevation of pondberry colonies on the DNF (ie. 95 feet NGVD) indicate that the colonies in Mississippi are likely located above the 15-20 year floodplain of larger rivers.

PONDBERRY PROFILE WORKSHOP

On 19 December 1990, GMI, in conjunction with U.S. Army Corps of Engineers, Vicksburg District, conducted a workshop at the District's Office. The workshop's attendees consisted of U.S. Army Corps of Engineers personnel, GMI personnel, U.S. Forest Service representatives, USFWS representatives and various pondberry experts from universities, The Nature Conservancy, and state Natural Heritage programs. The basic objectives of the meeting were to critically review the pondberry profile developed by GMI, to identify potential impacts of proposed flood control projects on pondberry colonies that may occur within project area and to determine the feasibility of developing a stratified sampling scheme for future surveys and possible surveying approaches.

The workshop participants provided two main conclusions. First, local precipitation and hydrology have more of an influence on the pondberry colonies than overbank flooding, since the colonies on the Delta National Forest are located above the 15-20 year floodplain. The group also concluded that subsequent surveys should be limited to mature bottomland hardwood communities with a mixture of heavy clays and silty loam soils and that cypress/tupelo swamps, scrub/shrub communities, and natural levees and point bars could be eliminated from future surveys.

A copy of the workshop's minutes is presented in Appendix B. Also included in Appendix B is a copy of a letter submitted by the Vicksburg District to each attendee asking for their thorough review

and comments of the minutes. No comments were received from any of the participants concerning the minutes.

RECOMMENDATIONS

Based upon the data gleaned from existing pondberry colonies and the workshop discussions, GMI suggests that subsequent surveys for pondberry can be limited to those areas which will be directly affected by construction, provided that the proposed project will not significantly alter local hydrology in areas where pondberry may occur. A buffer zone of at least 200 feet around construction areas should also be surveyed. If pondberry colonies are found within construction rights-of-way, mitigative measures such as realignment or transplanting would be necessary. In addition, pondberry colonies found within the 5-year floodplain of major streams may indicate a need to reevaluate habitat requirements and subsequent survey approaches.

Future field investigations, such as Habitat Evaluation Procedures (HEP) studies should, whenever practical, incorporate surveys for pondberry in order to locate unknown colonies that may aid in confirming/refuting current theories about the habitat requirements of pondberry.

APPENDIX A

ANNOTATED BIBLIOGRAPHY

Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plants of the South: Vol. 1 Isoetaceae through Euphorbiaceae. USDA Forest Service. Tech. Publ. R8-TP2, pp 459-462.

Brief report that gives technical description of pondberry. Also relates distribution and flowering season, special identification features, habitats, associated species, etc.

Klomps, V. L. 1980. Status Report on Lindera melissifolium (Walt.) Blume. Missouri Department of Conservation.

Sixteen page status report that discusses species information such as classification and nomenclature, present legal status at the time of the report, geographical distribution, environment and habitat, etc. This report gives assessments, recommendations, and information sources pertinent to pondberry.

Klomps, V. L. 1980. The Status of Lindera melissifolium (Walt.) Blume, Pondberry, in Missouri. Trans. Missouri Acad. Sci. 14:61-66.

This publication discusses the historical and current status of pondberry, its morphological characteristics, habitat and associated species in Missouri, and indicates unknowns such as habitat requirements, reproduction, pollination, disease, and predation.

Mansburg, Laura. 1983. Letter (with attachments) to Gary Tucker, Arkansas Tech University, dated 27 October 1983. North Carolina Department of Natural Resources and Community Development. Raleigh, North Carolina.

This letter and attachments summarize locations of pondberry in North Carolina and some ecological characteristics eg., associate species. Included as attachments were field notes by Ms. Julie Moore.

Morris, N.W. 1987. Lindera melissifolia in Mississippi. Castanea 51:226.

This article gives a brief description of known colonies in Mississippi and reveals a new location 6 miles northeast of Cleveland, MS, in Sunflower County. The habitat associated with the location is given along with relevant colony size, health, and associated species.

Radford, A.E. 1976. Vegetation - Habitats - Floras, Natural Areas in the Southeastern United States: Field Data and Information. University of North Carolina Student Stores, University of North Carolina, Chapel Hill.

Field notes from bog-sink forest in Berkeley County, South Carolina approximately 2 miles northeast of Honey Hill. Gives information on slope, canopy height, topsoil depth, soil pH, depth of water table, and delineates trees, shrubs, herbs, and forbs found on the site associated with pondberry.

Steyermark, J.A. 1949. Lindera melissaefolia. Rhodora 51:153-162.

This article reveals history of Lindera melissaefolia and relates confusion/obscurity associated with Lindera benzoin var. pubescens. The author discusses records and history of both pondberry and spice bush and describes morphological, physiological and other differences.

Tucker, G.E. 1974. The Vascular Plant Family Lauraceae in Arkansas. Ark. Acad Sci. Proc. 28:74-75.

This publication discusses four species in Arkansas that represent the family Lauraceae. These four are of the genera Lindera, Persea, and Sassafras. Pondberry is reported in Arkansas for the first time with keys, distribution maps, and other relevant information given.

Tucker, G.E. 1984. Status Report on Lindera melissifolia (Walt.) Blume. Provided under contract to the U.S. Fish and Wildlife Service, Southeast Region, Atlanta, Georgia.

This lengthy report gives an overall review of biology, ecology, description, distribution, and other relevant facts known about pondberry at the time of publication. The status report gives assessments of vigor, trends, critical habitat and gives recommendations for conservation/recovery. Sources of information/literature previously published as well as new information is also presented.

U.S. Fish and Wildlife Service. 1986. Endangered and threatened wildlife and plants: determination of endangered status for Lindera melissifolia. Federal Register. 51:27495-27499.

Final ruling which justifies determination of pondberry as an endangered species. Gives background information on population status, critical habitat, available conservation measures and summaries of comments, recommendations, and factors affecting the species.

U.S. Fish and Wildlife Service. 1990. Pondberry Technical Draft Recovery Plan. Atlanta, Georgia 52pp.

This draft report first gives a general species description and detailed technical description of pondberry. The current range and status along with the life history, reproductive for decline. Most importantly, a draft recovery plan is presented detailing objectives and methods to utilize in achieving those objectives. The recovery plan is based upon apparent habitat requirements and current status of Missouri populations of pondberry.

Wofford, B.E. 1983. A New Lindera (Lauraceae) from North America. J. Arnold Arbor. 64:325-331.

This publication mainly describes a potential new species, Lindera subcoriacea. In addition, this article also relates typical habitats, morphological and physiological characteristics, associated species, and other facts relative to pondberry.

ATTACHMENT 2

SURVEY REPORT
REEVALUATION OF PONDBERRY
IN MISSISSIPPI

Final

Survey Report
Reevaluation of Pondberry
in Mississippi

Prepared for:

U.S. Army Corps of Engineers, Vicksburg District
Planning, Programs, and Project Management Division
4155 Clay Street
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Prepared by:

Gulf South Research Corporation
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Baton Rouge, Louisiana 70820

August 25, 2000

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1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE), Vicksburg District, is currently investigating potential flood control alternatives in the Yazoo Backwater Area. Since there are known pondberry (*Lindera melissifolia*) locations in the project vicinity, the Vicksburg District needed to investigate the potential for the proposed project to affect extant pondberry communities.

Pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended, Federal agencies are obligated to insure that actions authorized, funded, or carried out are not likely to jeopardize the continued existence of any endangered species or result in adverse modification of critical habitat as determined by the U.S. Fish and Wildlife Service (USFWS). This report is generated as partial compliance with Section 7 of the ESA for the endangered pondberry.

The purpose of this study is to evaluate and update the existing pondberry profile relative to data gleaned from recently discovered colonies. Additional locations that have been discovered since the Vicksburg District performed previous pondberry surveys in the early 1990's were surveyed to characterize the new pondberry colonies.

The study area for this project includes the Delta National Forest (DNF) in Sharkey County, Mississippi, several parcels of private land located in Bolivar County, and a 32-acre plot located south of the DNF (Figure 1). Pondberry sites were surveyed between May 11 and June 20, 2000.

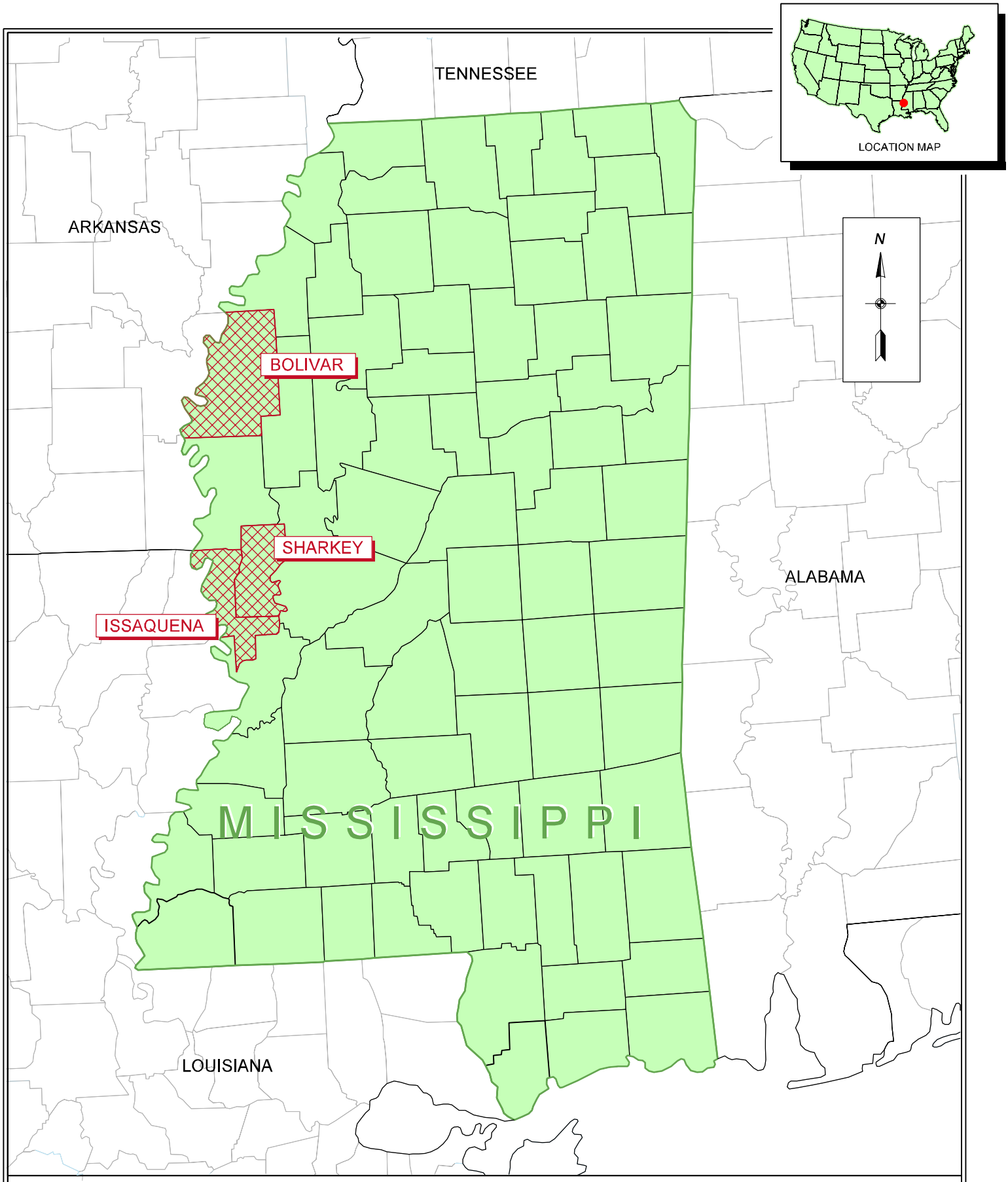

Figure 1: Project Study Area

gsrc GULF SOUTH RESEARCH CORPORATION

SCALE: NOT TO SCALE

DATE: AUGUST 2000

2.0 BIOLOGICAL PROFILE

Pondberry is a low growing, deciduous shrub ranging in height from 1.0 to 6.5 feet (ft) that occurs in seasonally flooded wetlands, on the wet edges of sinks, ponds, and depressions. Pondberry has been affected by habitat destruction and alteration, disease and predation, poor reproductive success, drainage or flooding of wetlands, and extreme weather conditions (USACE 1996). At present, there are at least 38 populations known to exist in Arkansas, Georgia, Mississippi, Missouri, and North and South Carolina; it has most likely been extirpated from Alabama and Louisiana (UFSWS 1993). The species was officially listed as endangered by the USFWS in 1986 under the ESA (USFWS 1986).

Pondberry plants are stoloniferous and grow in clones of stems, usually unbranched. The species is dioecious and the flowers of both sexes are small and pale yellow. The mature fruit is a red drupe about 0.39 in long that matures in late summer or fall. Few details are known about the reproductive biology of pondberry. Due to the similarity between the flowers of pondberry and spicebush (*Lindera benzoin*), it is suspected that pondberry is insect pollinated (USACE 1996). Many populations consist predominantly of male plants. A mature colony often consists of a mixture of live and dead stems (USFWS 1993) with some evidence of dieback. Dieback is defined as the death of the tips of live stems. Devall *et al*. (nd) suggested that since dieback was present in all populations examined and that it has persisted for the last 20 years in the Missouri population, it was not a limiting factor in pondberry growth.

A profile was completed by the USACE in 1991 which determined that pondberry within Mississippi should occur on slight ridges, is frequently or periodically flooded, or is within 100 ft of a permanent waterbody, and is typically located on soils with a mixture of heavy clays and lighter soils. This study determined that common associate tree species were oaks, sweetgum, and elms and common associate shrub species were American snowbell, deciduous holly, and palmetto. The report also indicated that local precipitation and hydrology influence pondberry more than overbank flooding.

3.0 METHODS

Data were collected from existing pondberry colonies within the DNF, on private lands in Bolivar County, Mississippi, and a 32-acre plot south of the DNF. The team also surveyed portions of the Dahomey National Wildlife Refuge in northern Mississippi. A team of five people including an ecologist, three biologists, and one field technician performed the data collection. Compartment maps supplied by the Forest Service delineating known pondberry colonies in DNF were used to facilitate colony location in the field (USFS 2000). Each colony was given a unique colony ID number and recorded using GPS. The team collected numerous physical and biological data at each site (Appendix A).

Soil samples were collected at each site and classified according to Munsell Soil Color Charts (2000) for physical attributes (silt, loam, clay, etc.).

Elevations and distances were subsequently measured by a team of surveyors, led by a registered land surveyor (Pyburn and Odom, Inc. 2000).

Canopy cover was measured with a densiometer near the center of each pondberry colony. Ocular estimates for herbaceous cover was made by each member of the field team to develop a consensus. Associated species were recorded within a 0.1 acre plot surrounding the colony at each vegetational layer (i.e., overstory, understory, shrubs, and herbaceous cover). Diameter of overstory species within the 0.1 acre plot were measured using a diameter breast height (DBH) tape.

With the exception of the very large colonies, individual stems of each pondberry colony were counted and recorded. Stems were considered an individual plant if there was no connection to other stems at or near the ground. For large colonies, such as the ones found in Compartment 16 and at Shelby, Mississippi, the density of stems was found by sub-sampling five randomly selected one-meter plots within the colony. However, each female stem was counted and recorded, regardless of the size of the colony. Female stems were identified by the presence of maturing fruit.

The general health of the colony was a subjective value reached by the consensus of the team based upon the ratio of dying stems to live stems, physical appearance of the

stem and leaves, and overall density of the colony. The presence of insect damage, fungal damage, or dieback was also noted.

Health of the colony was then quantified using density per square feet (ft^2), which was calculated by dividing the number of stems in the colony by the total area of the colony.

Field data were compiled into a database and pertinent quantitative field data were statistically analyzed using Microsoft Excel™ software program. The analyses performed included means, standard deviations, ranges, and correlation coefficients.

4.0 RESULTS

4.1 General Data

A total of 62 pondberry colonies were surveyed, 12 of which were not located in the Delta National Forest (Figures 2-4). Appendix B presents data collected from all pondberry sites surveyed. Within the DNF, pondberry sites were relocated in compartments 1-4, 7, 14, 16, 25, 28, 30, 38-39, and 47. The 12 colonies not located in DNF were on private lands that supported small (less than five acres) bottomland hardwood communities surrounded by croplands, primarily cotton, soybeans, and rice. The field team was unsuccessful in relocating three colonies due to a recent salvage cut within the area, as well as the difficulty in identifying small pondberry colonies during the time of year when similar sized and shaped herbaceous species are thriving. No pondberry colonies were found on the Dahomey National Wildlife Refuge, although extensive colonies of a closely related species, spicebush (*Lindera benzoin*), were located. Additionally, no pondberry colonies were found on the 32-acre plot south of the DNF, which is the proposed Yazoo River Backwater pumping plant site.

Statistical analyses were performed on various data collected during the field surveys using regression analysis. A correlation coefficient is a number between –1 and +1 that describes the relationship between values and is expressed as an r value. The sign of the r indicates the type of relationship, whether positive or negative and the value of r without regard to sign indicates the strength of the linear relationship. The more closely a value of r approaches 1 (+/-), the stronger the relationship. Conversely, the more closely the value of r approaches 0, the weaker the relationship. The square of the correlation coefficient, r^2, indicates the proportion of total variance in one variable that is predictable; in other words, it is a direct measure of the strength of a relationship.

4.2 Physical Data

The approximate size of the pondberry colonies, as calculated by the surveyors, ranged from 21 ft^2 to 9000 ft^2 with an average of 1988 ft^2. All but four colonies (93%) were found in areas of localized depressions.

The average distance of a colony from a standing body of water, as measured by the surveyors, was approximately 64 ft. Of the 50 colonies in the DNF, the average distance of a colony from a waterbody was 80 ft. Only the colonies found at Shelby and Merigold

were found in areas inundated with water, or areas of recent inundation. None of the colonies surveyed at DNF were found in standing water; however, approximately half of the colonies surveyed were in areas that could potentially hold water.

According to the Natural Resources Conservation Service (NRCS), the two dominant soil associations found in the DNF are the Sharkey-Alligator-Dowling and the Forestdale-Dundee-Dowling Associations (NRCS 1962). The Sharkey-Alligator-Dowling Assocation consists of poorly drained, clayey soils in slack-water areas. This association is found in areas where the slope is generally less than two percent, but may be as much as five percent along streambanks and depressions. The Forestdale-Dundee-Dowling

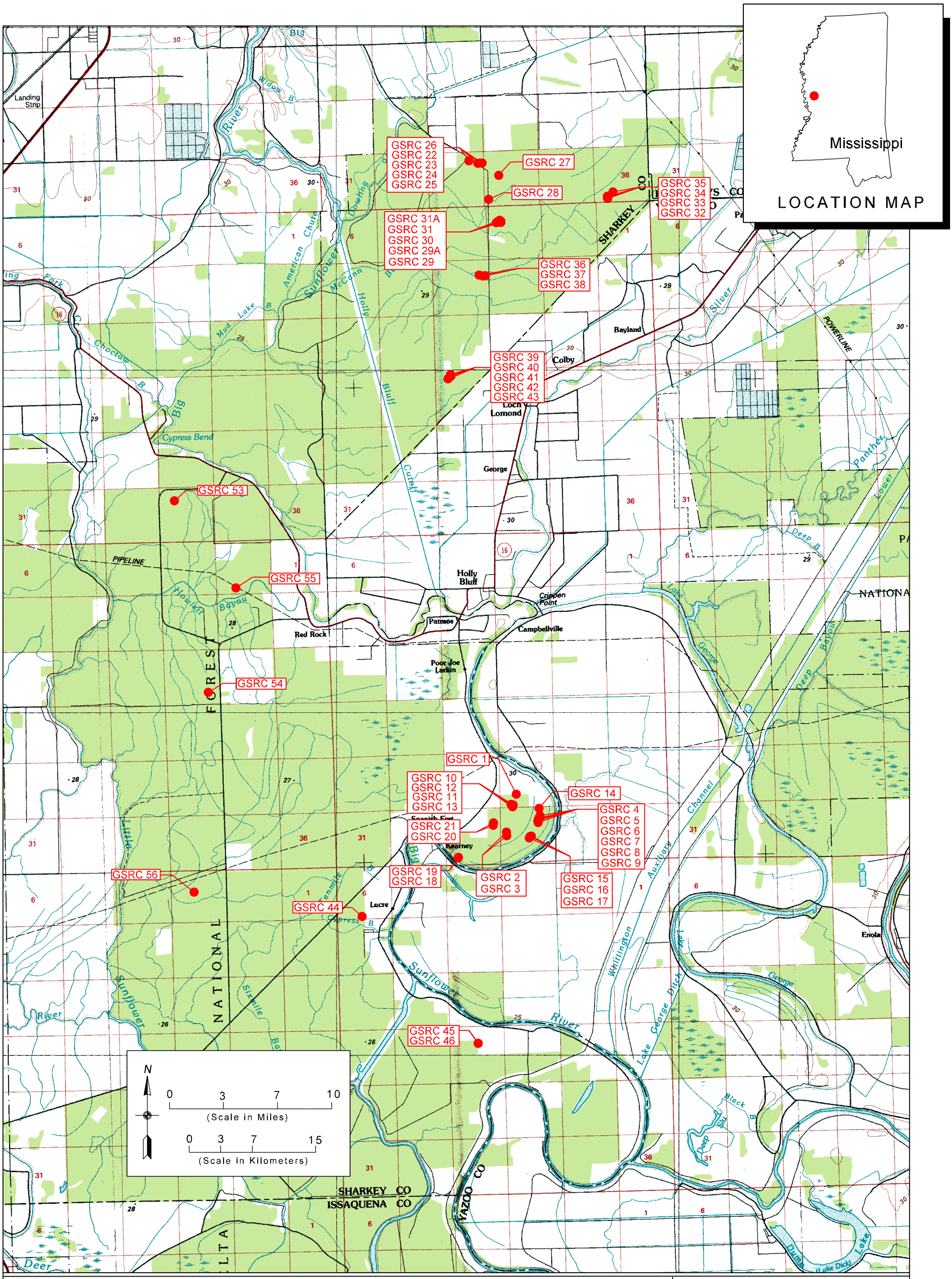

Figure 2: Pondberry Site Locations in Delta National Forest

Scale: on map

Date: August 2000

gsrc GULF SOUTH RESEARCH CORPORATION

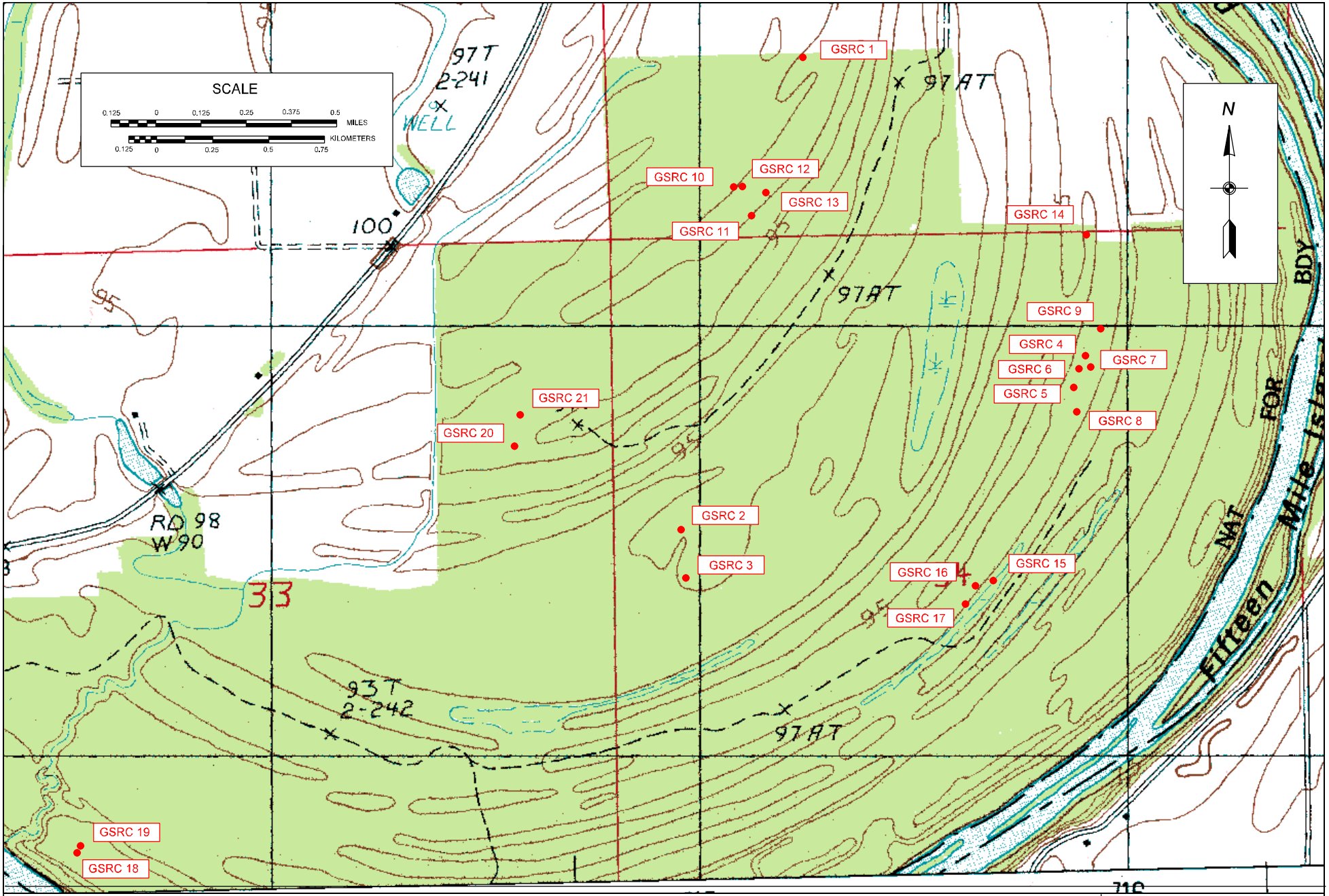

Figure 3: Pondberry Site Locations in Compartment 39 of Delta National Forest

gsrc / GULF SOUTH RESEARCH CORPORATION

SCALE: 1:12,000

DATE: August 2000

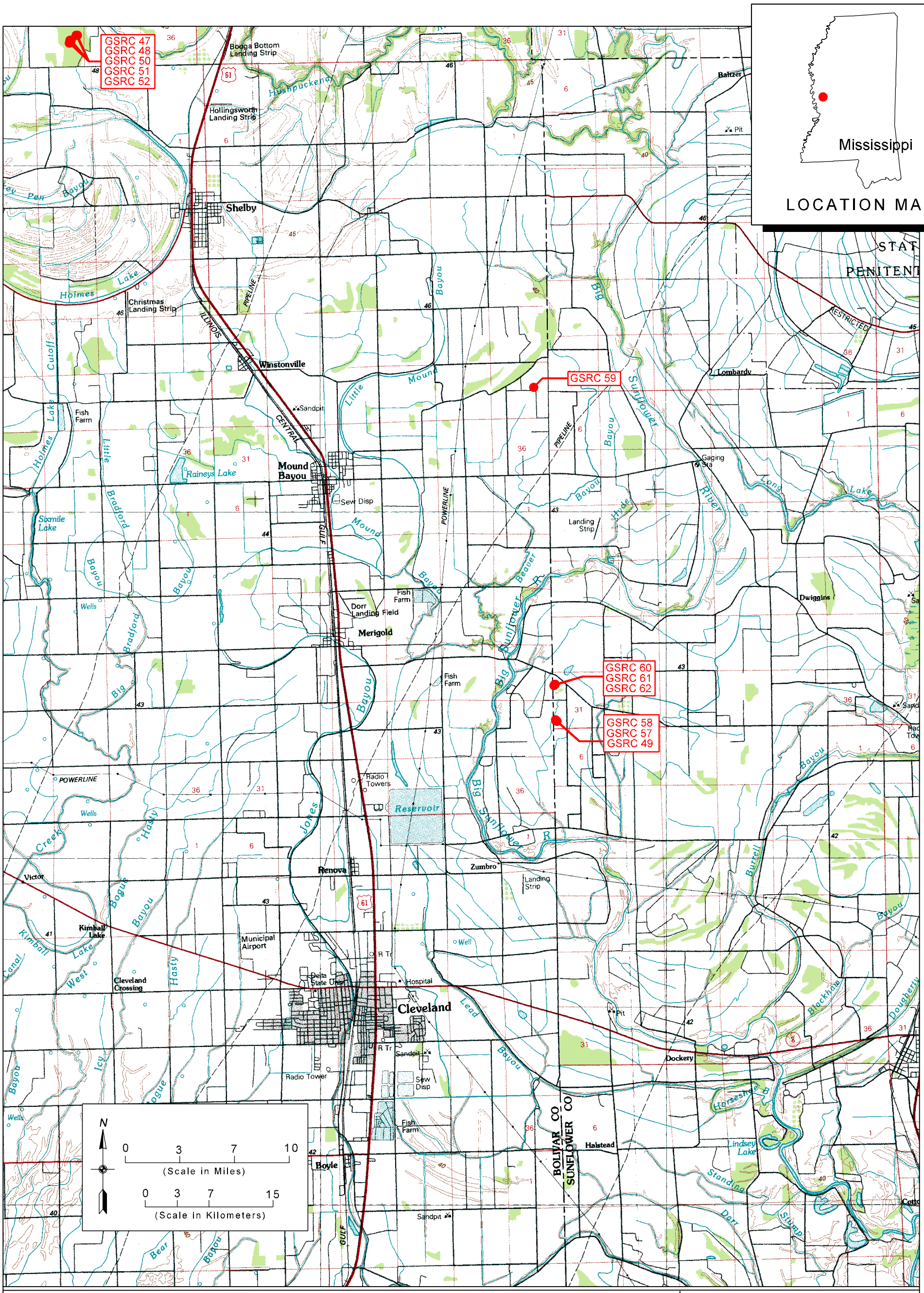

Figure 4: Pondberry Site Locations near Shelby/Merigold, Bolivar County

Scale:	on map
Date:	August 2000

gsrc GULF SOUTH RESEARCH CORPORATION

Association consists of poorly drained soils that formed in moderately fine textured alluvium from the Mississippi River and its tributaries. The soils found at the colony sites were classified as clay loams or silty clay.

The elevations of the 62 colonies sampled ranged from 88 ft to 155 ft National Geodetic Vertical Datum (NGVD). The elevations of the 50 colonies surveyed on the DNF ranged from 88 to 99 ft NGVD. Based upon the surveyed elevations at each site and the slope-adjusted surface water elevations for various flood frequencies (Appendix B), these colonies occurred, on average, within the 6-year floodplain. The majority (45%) of the colonies in the DNF were found within the 2-5 year floodplain. The other colonies were distributed fairly evenly throughout the floodplains with 18% in the 0-2 year floodplain, 18% in the 5-10 year floodplain, 4% in the 10-15 year floodplain, and 14% in the 15-20 year floodplain. The correlation coefficient for pondberry density and flood frequency was calculated to be 0.063, which indicates that there is not a strong relationship between pondberry density and flood frequency. The elevations of the remaining 12 colonies surveyed at Shelby and Merigold ranged from 136 to 155 ft NGVD. All of these sites were located above the 100 year floodplain. Floodplain data for existing pondberry colonies are presented in Table 1. Floodplain data with project for pondberry colonies are presented in Table 2.

Table 1

Existing Flood Frequency Data for Pondberry Sites

Floodplain	Delta National Forest		Shelby/Merigold	
	Number of Colonies	Percent	Number of Colonies	Percent
0-2 year	9	18%	--	--
2-5 year	22	45%	--	--
5-10 year	9	18%	--	--
10-15 year	2	4%	--	--
15-20 year	7	14%	--	--
> 100 year	--	--	12	100%
Average	6-year floodplain		> 100 year floodplain	

Table 2

With Project Flood Frequency Data for Pondberry Sites

Floodplain	Delta National Forest		Shelby/Merigold	
	Number of Colonies	Percent	Number of Colonies	Percent
0-2 year	2	4%	--	--
2-5 year	6	12%	--	--
5-10 year	5	10%	--	--
10-15 year	3	6%	--	--
15-20 year	4	8%	--	--
20-100 year	16	27%		
> 100 year	16	33	12	100%
Average	45-year floodplain		> 100 year floodplain	

4.3 Biological Data

4.3.1 Associated Vegetation

The three most common overstory species associated with the 62 pondberry colonies surveyed were sweetgum (*Liquidambar styraciflua*), willow oak (*Quercus phellos*), and Nuttall oak (*Quercus nuttallii*). The three most common understory species associated with the 62 colonies were sweetgum, red maple (*Acer rubrum* var. *drummondii*), and sugarberry (*Celtis laevigata*). The three most common shrub species associated with the pondberry sites sampled were sugarberry, swamp dogwood (*Cornus drummondii*), and deciduous holly (*Ilex decidua*). Other shrub species found in high abundance near the colonies were persimmon (*Diospyros virginiana*), American elm (*Ulmus americana*), red maple, and green ash (*Fraxinus pennsylvanica*). Poison ivy (*Toxicodendron radicans*) was found at all but two sites. The other most common vine and herb species found near the pondberry colonies were green briar *(Smilax* sp.), pepper vine (*Ampelopsis arborea*), and muscadine vine (*Vitis rotundifolia*). Virginia creeper (*Parthenocissus quinquefolia*), trumpet creeper (*Campsis radicans*), rattan (*Berchemia scandens*), blackberry (*Rubus* sp.), false nettle (*Boehermia cylindrica*), and lady's ear drops (*Brunnichia cirrhosa*) were also commonly found near the pondberry colonies. Appendix C presents the entire list of species found near the pondberry colonies.

The approximate percent canopy cover of the 62 colonies sampled ranged from 40% to 99% with an average of 87% (Figure 5). The percent canopy cover of the 50 colonies surveyed on the DNF ranged from 70% to 99% with an average of 90%. The percent canopy cover of the 12 remaining colonies ranged from 40% to 95% with an average of 77%. The correlation coefficient for pondberry density and percent canopy cover was calculated to be 0.124, which indicates that there is not a strong relationship between percent canopy cover and pondberry density.

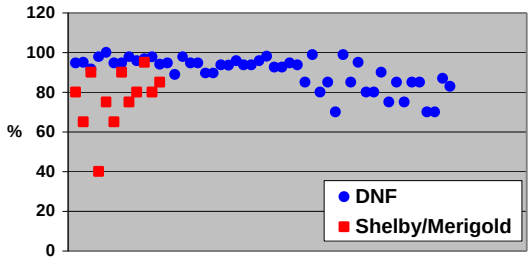

Figure 5

Percent Canopy Cover

The approximate diameter breast height (DBH) of the overstory tree species near the 62 pondberry colonies ranged from 9.3 inches (in) to 45.8 in with an average of 20.4 in (Figure 6). The correlation coefficient for elevation and DBH was calculated to be –0.007, which indicates that there is a slightly negative relationship, but that there is not a strong relationship between DBH and pondberry density.

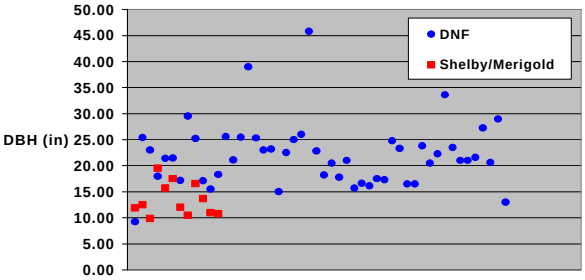

Figure 6

Overstory Tree Species Diameter (DBH)

The approximate percent herbaceous cover around the pondberry colonies ranged from 1% to 98% with an average of 63% (Figure 7). A correlation coefficient was not

calculated for percent herbaceous cover and pondberry density due to the seasonal nature of herbaceous species.

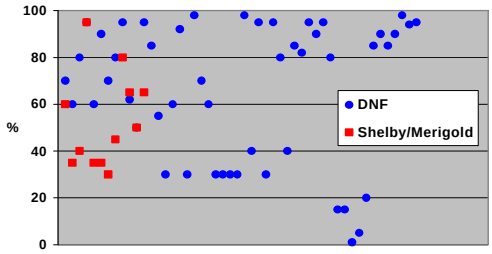

Figure 7

Percent Herbaceous Cover

4.3.2 Pondberry

The approximate height of the pondberry stems ranged from 10 in to 62 in with an average of 21 in. The correlation coefficient calculated for height of pondberry stems and elevation was 0.069, which indicated that there is not a strong relationship. The approximate diameter of the pondberry stems ranged from 0.037 in to 0.875 in with an average of 0.315 in. The correlation coefficient calculated for stem diameter and elevation was –0.014, which indicated that there was a slightly negative relationship, but that it was not very strong. Of the 62 colonies sampled, 27 had evidence of fungal damage, 42 had evidence of insect damage, and 52 had evidence of dieback. Twenty five (40%) of the colonies were classified as being in excellent condition, 29 (46%) as in good condition, 8 (13%) as in fair condition, and only one (<1%) in poor condition.

The density of pondberry stems ranged from 0.01 to 21 ft^2 with an average of 1.6 ft^2 for all 63 colonies sampled. The density of stems for the DNF ranged from 0.12 to 10.2 ft^2 with an average of 1.01; the remaining density for Shelby and Merigold ranged from 0.07 to 21 ft^2 with an average of 3.61 ft^2. The density of dead pondberry stems ranged from zero to 23.1 per ft^2 with an average of 0.65 per ft^2. The density of dead stems for the DNF ranged from zero to 2.07 per ft^2 with an average of 0.13 per ft^2; the remaining number of dead stems for Shelby and Merigold ranged from zero to 20 per ft^2 with an average of 2.63 per ft^2. The correlation coefficient calculated for the relationship between elevation and density of pondberry stems is 0.111, which indicated that there was not a strong relationship.

5.0 CONCLUSIONS

The results of this survey are similar to the results of the pondberry profile conducted by the USACE in 1991. They determined that a typical pondberry colony found within Mississippi Delta should occur on slight ridges in a ridge and swale community which is periodically flooded. Results from this current study indicated that the average elevations of pondberry colonies were within the 6-7 year floodplain. These results are similar to those from another study conducted by the USACE in 1996. Although this study determined that the pondberry colonies found within the DNF occurred within the 6-year floodplain on average, the majority of the colonies were located within the 2-5 year floodplain. However, the results of this study concur with previous reports that pondberry is more likely to be influenced by local precipitation and hydrology, rather than by overbank flooding. It must be noted that pondberry colonies located within a 5-year floodplain will not necessarily be flooded every five years. The presence of barriers, such as levees, roads, structures, or natural ridges will also affect the flooding near colonies even when a 5-year storm event occurs.

This study found that common associate species were similar to previous studies on the Mississippi pondberry populations. Common associate tree species were sweetgum, oaks, and elms while associate shrub species were sugarberry, swamp dogwood, and deciduous holly. However, it should be noted that the DNF is managed for oaks, so the importance of oaks as associate species may be over-estimated. The field team noted that spicebush was absent in areas where pondberry was present. The reverse was also true at Dahomey National Wildlife Refuge, where extensive colonies of spicebush, but not pondberry, were found.

Previous studies suggested that pondberry colonies in Mississippi are shade tolerant and probably shade dependent (USACE 1991a, b). A recent study by Devall *et al*. (nd) reported that the most vigorous colonies they observed were in locations with abundant light. However, these colonies were found in Georgia, in an entirely different habitat type. Devall *et al.* (nd) also reported that colonies in Mississippi were also found in areas of high canopy cover. The colonies surveyed in this study were found in areas of high percent canopy cover (average 90%). In addition, colonies located in areas of low percent canopy cover generally had a high abundance of competition from vines (Figure 8). This evidence suggests that pondberry colonies located in the DNF are indeed

shade tolerant, and possibly shade dependent, as indicated by previous studies in this area (USACE 1991a, b).

Based on physical and biological data, there was no correlation between health of the colony, measured by either stem density, stem diameter, or stem height, and elevation. There was also no correlation between health of the colony, measured by stem density, and percent canopy cover or DBH. Therefore, it is difficult to predict where pondberry might be successful by using these quantifiable variables. Instead, evidence from this and previous studies suggest that, in general, pondberry is successful in areas of high percent canopy cover, in a ridge and swale community, and in areas that are mostly affected by local precipitation and hydrology.

Interestingly, pondberry colonies found in Bolivar County, approximately 65 miles north, differed from colonies found in the DNF. Colonies near Shelby were large, healthy colonies; however, one parcel of land contained colonies with very high amounts of dieback and dead stems (Figure 9). It was suggested at the June 22, 2000 workshop by Margaret Devall of the Center for Bottomland Hardwood Research that this die-off was caused by abnormally low temperatures during late winter 1999.

Pondberry colonies found near Merigold were in small parcels of forested land surrounded by crop fields, primarily rice fields. All of these colonies had been recently inundated with water from the nearby rice fields. Little dieback was observed in these areas; however, leaves were observed to be slightly wilted.

In conclusion, it is unlikely that pondberry would be affected by changes in the flood regime in the Yazoo Backwater Area. The 1991 profile, the 1996 Biological Assessment, and this study indicate that the pondberry colonies in the DNF are influenced more by local hydrology, rather than overbank flooding. The proposed flood control would not affect local hydrology and thus would not directly or indirectly affect the pondberry colonies. Since the colonies within the Yazoo Backwater project area are located on Federal lands (i.e., DNF), reductions in flood frequencies would not induce additional clearing of bottomland hardwood communities that could potentially impact pondberry populations.

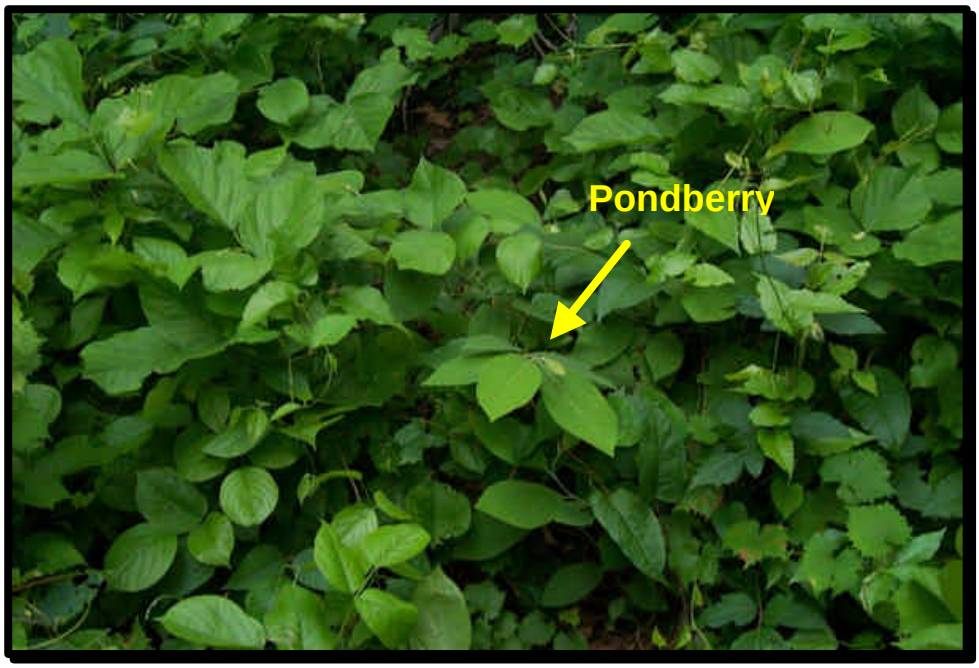

Figure 8

Pondberry colony with competition from vines.

Figure 9

Pondberry colony with dead stems in Bolivar County (near Shelby)

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7.0 LIST OF PREPARERS

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APPENDIX A

SAMPLE DATA SHEET

PONDBERRY DATA FORMS

Recorder: _____ Sampler (s): _____ Date: _____
Location: _____ Colony ID: _____
Photo Number: _____

PONDBERRY COLONY DATA

Number of clumps_____ Average no. stems within clumps_____
Approx. no. of stems_____ No. of female stems_____
Average height of stems (in)_____ No. of fruits on females_____
Average diameter of stems_____

Health of colony Excellent Good Fair Poor
Fungal damage Yes No
Insect damage Yes No
Dieback Yes No

TOPOGRAPHIC INFORMATION

GPS Location North_____ East_____ LMK#_____
Location description_____
_____
Water depth on plot_____
Distance to nearest body of water_____
General soil type_____
Munsell soil color:

ASSOCIATED VEGETATION

Percent Canopy Cover _____
DBH_____
% herbaceous cover_____
Average tree stand maturity 6" 6-18" >18" Mixed

Overstory Species

Sweetgum	Willow oak	Cypress	_____
Pecan sp.	American elm	Green ash	_____
Overcup oak	Nuttall oak		_____
Water oak	Water hickory		_____

Understory Species

Sweetgum	Blackgum	Box elder	_____
Red maple	Basswood	Dogwood	_____
Sugar berry	Water oak	Red mulberry	_____
Pecan sp.	Willow oak	Nuttall oak	_____
American elm	Chestnut oak	Green ash	_____

Shrubs

Sabal palm	Swamp dogwood	Red maple	Cedar elm	Box elder
Persimmon	Water oak	Red mulberry	Black hawthorn	
Deciduous holly	Willow oak	Am. Snowbell	Green ash	
Sugar berry	Chesnut oak			
Honey locust	Nuttall oak			
Pecan	American elm			

Herbs and Vines

Poison ivy	Rattan	Ebony spleenwort		
Muscadine	Rubus	Oxalis sp.	Moonseed	_____
Virginia creeper	Lactuca	Sassafras	Smilax	_____
Trumpet creeper	Spanish nettle	Persimmon	Rhyncocia	_____
Pepper vine	False nettle	Lady's ear drops		_____
Fox grape	Swamp violet	Pokeweed		

NOTES:

_____
_____
_____
_____

APPENDIX B

PONDBERRY DATA

APPENDIX B
PONDBERRY DATA

Colony ID	Compartment	Date	Percent Canopy Cover	DBH (in)	Herbaceous cover	Tree Stand Maturity	No. Clumps	No. Stems	Area of Plot (ft^2)
GSRC 01	39	11-May-00	94.8	9.25	70%	Mixed	1	2	56
GSRC 02	39	11-May-00	95.08	25.40	60%	6-18	2	36	300
GRSC 03	39	11-May-00	91.68	23.00	80%	6-18	3	70	2000
GSRC 04	39	11-May-00	97.87	18.00	95%	>18	2	142	--
GSRC 05	39	11-May-00	99.96	21.40	60%		2	8	--
GSRC 06	39	11-May-00	94.8	21.50	90%	Mixed	4	10	--
GSRC 07	39	12-May-00	94.8	17.20	70%	Mixed	1	14	--
GSRC 08	39	12-May-00	97.92	29.50	80%	6-18	1	6	150
GSRC 09	39	12-May-00	95.84	25.20	95%	>18	8	133	--
GRSR 10	39	12-May-00	96.88	17.10	62%	>18	7	11	200
GSRC 11	39	12-May-00	97.82	15.50	50%	>18	2	37	504
GSRC 12	39	12-May-00	94.16	18.30	95%	>18	5	21	1080
GSRC 13	39	12-May-00	94.8	25.60	85%	>18	1	6	504
GSRC 14	39	15-May-00	88.89	21.09	55%	>18	3	13	150
GSRC 15	39	15-May-00	97.9	25.45	30%	>18	8	143	3990

APPENDIX B
PONDBERRY DATA

Colony ID	Stems per ft^2	Stems within Clump	Dead Stems per ft^2	Avg. Diameter of Stems (in)	Avg. Height of Stems (in)	Fungal Damage	Insect Damage	Dieback
GSRC 01	0.0357	2.00	0.0000	0.1	12	1		
GSRC 02	0.1200	18.00	0.0000	0.3125	24	1	1	1
GRSC 03	0.0350	23.33	0.0020	0.3125	21	1	1	1
GSRC 04		71.00		0.3125	13			1
GSRC 05		4.00		0.3125	10		1	
GSRC 06		2.50		0.3125	16			
GSRC 07		14.00		0.3125	13			1
GSRC 08	0.0400	6.00	0.0000	0.3125	14			1
GSRC 09		16.63		0.3125	24	1		1
GRSR 10	0.0550	1.57	0.0000	0.3125	15			1
GSRC 11	0.0734	18.50	0.0000	0.3125	22	1	1	1
GSRC 12	0.0194	4.20	0.0019	0.3125	17		1	1
GSRC 13	0.0119	6.00	0.0020	0.4375	23	1	1	1
GSRC 14	0.0867	4.33	0.0333	0.5	14	1		1
GSRC 15	0.0358	17.88	0.0010	0.25	12	1	1	1

APPENDIX B
PONDBERRY DATA

Colony ID	Health of Colony	Soil Type	Munsell Soil Color	Distance to Water (ft)	Iron-Rod Elevation	Average Elevation	Floodplain Frequency (years)	Depression	Comments
GSRC 01	Excellent	clay	0-2 organic; 2-depth 10YR6/2, 50% mottling 10YR5/6	70	94.55	94.69	4.5	1	332 m from parking area; 120 ft from GPS point
GSRC 02	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 40% mottling 10YR6/8	50	91.05	91.20	1.5	1	
GRSC 03	Good	clay	0-2 organic; 2-depth 10YR6/1, 40% mottling 10YR6/8	70	91.65	91.50	1.5	1	lots of competition with Rhyncocia and poison ivy
GSRC 04	Excellent	grainy clay	0-2 organic; 2-depth 7.5YR, 10% mottling	94	97.44	97.65	16.0	1	no water in drain
GSRC 05	Good	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	80		95.09	5.0	1	no water in drain; 115 SW from GRSC 04
GSRC 06	Good	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	40	96.39	96.37	9.0	1	no water in drain
GSRC 07	Good	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	40	96.93	95.94	7.0	1	no water in drain
GSRC 08	Good	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	70	95.7	95.44	6.0	1	no water in drain
GSRC 09	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	37	97.22	97.28	15.0	1	no water in drain; lots of competition from vines
GRSR 10	Good	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/1	107	93.79	94.16	4.0	1	no water in drain; leaf rolled up with insect web
GSRC 11	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	177	96.21	95.98	7.5	1	no water in drain
GSRC 12	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	147	95.63	96.10	7.5	1	no water in drain
GSRC 13	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	175	96.53	96.80	11.0	1	less competition than others, right in the middle of old logging road
GSRC 14	Excellent	clay	0-2 organic; 2-5 10YR4/2; 5-depth 10YR5/1, 30% mottling 10YR4/6	34	93.7	93.86	3.5	1	60 ft from field near the ditch
GSRC 15	Good	clay	0-2 organic; 2-5 10YR4/2; 5-depth 10YR5/1, 30% mottling 10YR4/6	70	94.32	93.85	3.5	1	located on ridge alongside a depression with standing water

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PONDBERRY DATA

Colony ID	Compartment	Date	Percent Canopy Cover	DBH (in)	Herbaceous cover	Tree Stand Maturity	No. Clumps	No. Stems	Area of Plot (ft^2)
GSRC 16	39	15-May-00	94.8	39.00	60%	6-18	3	40	600
GSRC 17	39	15-May-00	94.8	25.30	92%	>18	14	262	--
GSRC 18	39	16-May-00	89.67	23.00	30%	Mixed	1	424	1836
GSRC 19	39	16-May-00	89.67	23.20	98%	>18	4	20	1410
GSRC 20	39	16-May-00	93.76	15.00	70%	Mixed	3	218	2546
GSRC 21	39	16-May-00	93.62	22.50	60%	>18	1	72	836
GSRC 22	39	17-May-00	95.84	25.00	30%	Mixed	3	34	1450
GSRC 23	2	17-May-00	93.76	26.00	30%	Mixed	1	3	21
GSRC 24	2	17-May-00	93.76	45.80	30%	Mixed	5	16	450
GSRC 25	2	17-May-00	95.84	22.83	30%	>18	1	2	--
GSRC 26	4	17-May-00	98.08	18.20	98%	>18	13	148	5896
GSRC 27	2	17-May-00	92.72	20.50	40%	Mixed	4	15	264
GSRC 28	4	17-May-00	92.72	17.80	95%	>18	6	48	--

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Colony ID	Stems per ft^2	Stems within Clump	No. Females	No. Fruits	No. Dead Stems	Dead Stems per ft^2	Avg. Diameter of Stems (in)	Avg. Height of Stems (in)	Fungal Damage	Insect Damage	Dieback
GSRC 16	0.0667	13.33	0	0	3	0.0050	0.3125	22	1	1	1
GSRC 17		18.71	1	1	19		0.25	30	1	1	1
GSRC 18	0.2309	424.00	0	0	63	0.0343	0.5	27	1	1	1
GSRC 19	0.0142	5.00	6	14	0	0.0000	0.5	24	1	1	
GSRC 20	0.0856	72.67	6	13	50	0.0196	0.0375	17	1	1	
GSRC 21	0.0861	72.00	0	0	16	0.0191	0.625	15		1	
GSRC 22	0.0234	11.33	0	0	2	0.0014	0.125	18	1	1	1
GSRC 23	0.1429	3.00	0	0	0	0.0000	0.25	14			1
GSRC 24	0.0356	3.20	0	0	2	0.0044	0.25	11		1	1
GSRC 25	2.0000	2.00	0	0	0		0.25	15		1	
GSRC 26	0.0251	11.38	0	0	0	0.0000	0.625	24	1	1	1
GSRC 27	0.0568	3.75	0	0	0	0.0000	0.25	13		1	
GSRC 28		8.00	0	0	1		0.875	26			1

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PONDBERRY DATA

Colony ID	Health of Colony	Soil Type	Munsell Soil Color	Distance to Water (ft)	Iron-Rod Elevation	Average Elevation	Floodplain Frequency (years)	Depression	Comments
GSRC 16	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	78	92.43	92.72	2.5	1	located on ridge alongside a depression with standing water
GSRC 17	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	40	92.77	93.69	3.5	1	insect use of leaves with web; large and spread out colony, thick vegetation and near standing water
GSRC 18	Excellent	clay	0-1 organic; 1-3 10YR3/1, 10% mottling 10YR3/4; 3-12 10YR5/1, 20% mottling 10YR3/4	40	92.28	92.66	2.5	1	good colony in fairly open clearing; very dense clump with little vegetation, near Yazoo River
GSRC 19	Good	clay	0-1 organic; 1-3 10YR3/1, 10% mottling 10YR3/4; 3-12 10YR5/1, 20% mottling 10YR3/4	89	91.07	91.98	2.0	1	tall sassafras and pokeweed within clump; very distinct clumps under little canopy; competition with thick vines
GSRC 20	Excellent	clay	0-2 organic; 2-4 10YR3/1; 4-12 10YR3/1; 10% mottling 10YR6/8	118	92.95	93.58	3.0	1	in one large clump with a few others scattered
GSRC 21	Good	clay	0-2 organic; 2-4 10YR3/1; 4-12 10YR3/1; 10% mottling 10YR6/8	65	92.47	91.68	2.0	1	insect use of leaf
GSRC 22	Good	clay	0-2 organic; 2-5 10YR3/1; 5-10 10YR4/1, 10% mottling 10YR5/8	--	98.34	98.52	17.0	1	very spread out and individual stems
GSRC 23	Fair	clay	0-2 organic; 2-5 10YR3/1; 5-10 10YR4/1, 10% mottling 10YR5/8	--	98.2	98.22	15.0	1	small colony
GSRC 24	Good	clay	0-2 organic; 2-5 10YR3/1; 5-10 10YR4/1, 10% mottling 10YR5/8	--	98.15	98.24	15.0		insect use of leaf; very scattered clumps
GSRC 25	Good	clay	0-2 organic; 2-5 10YR3/1; 5-10 10YR4/1, 10% mottling 10YR5/8	--	98.06	98.11	14.0		very small colony
GSRC 26	Good	clay	0-2 organic; 2-5 10YR3/1; 5-6 10YR4/2; 6-12 10YR6/3, 10% mottling 10YR5/6	--	99.57	98.18	15.0	1	huge colony with distinct clumps on ridge NE of bayou, lots of competition with vines; fairly tall stems; 100 ft from power line road
GSRC 27	Good	clay	0-2 organic; 2-5 10YR3/1; 5-10 10YR4/1, 10% mottling 10YR5/8	--	98.1	98.31	16.0	1	small colony within boundary; stems healthy but scattered
GSRC 28	Good	clay	0-1 organic; 1-3 organic-rich soil; 3-6 10YR 5/4; 6-10 10YR6/3, 10% mottling, 10YR6/6	--	96.86	97.07	7.0	1	colony is E (130) of boundary line marked with organge tape; overtaken by briars

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Colony ID	Compartment	Date	Percent Canopy Cover	DBH (in)	Herbaceous cover	Tree Stand Maturity	No. Clumps	No. Stems	Area of Plot (ft^2)
GSRC 29	3	18-May-00	94.8	21.00	30%	Mixed	11	485	8625
GSRC 30	3	18-May-00	93.76	15.70	95%	Mixed	4	300	5016
GSRC 31	3	23-May-00	85	16.60	80%	Mixed	10	1800	9000
GSRC 32	1	23-May-00	99	16.10	40%	6-18	1	9	112
GSRC 33	1	23-May-00	80	17.50	85%	>18	2	22	1053
GSRC 34	1	23-May-00	85	17.30	82%	6-18	1	10	252
GSRC 35	1	23-May-00	70	24.80	95%	>18	3	25	270
GSRC 36	7	23-May-00	99	23.30	90%	>18	1	11	256
GSRC 37	7	23-May-00	85	16.50	95%	>18	7	161	5100
GSRC 38	7	23-May-00	95	16.50	80%	Mixed	1	31	990
GSRC 39	16	24-May-00	80	23.80	15%	>18	1	12	210
GSRC 40	16	24-May-00	80	20.50	15%	>18	1	5	286
GSRC 41	16	24-May-00	90	22.30	1%	Mixed	3	46	660
GSRC 42	16	24-May-00	75	33.60	5%	>18	1		1850

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Colony ID	Stems per ft^2	Stems within Clump	No. Females	No. Fruits	No. Dead Stems	Dead Stems per ft^2	Avg. Diameter of Stems (in)	Avg. Height of Stems (in)	Fungal Damage	Insect Damage	Dieback
GSRC 29	0.0562	44.09	0	0	90	0.0104	0.625	22			
GSRC 30	0.0598	75.00	0	0	42	0.0084	0.5	22		1	1
GSRC 31	0.2000	180.00	100	20	40	0.0044	0.5	20	1	1	1
GSRC 32	0.0804	9.00	0	0	2	0.0179	0.125	18			1
GSRC 33	0.0209	11.00	1	1	0	0.0000	0.125	17			1
GSRC 34	0.0397	10.00	0	0	0	0.0000	0.125	14			1
GSRC 35	0.0926	8.33	0	0	0	0.0000	0.2	16			1
GSRC 36	0.0430	11.00	1	10	1	0.0039	0.125	24		1	1
GSRC 37	0.0316	23.00	15	3-60	12	0.0024	0.375	24	1	1	1
GSRC 38	0.0313	31.00	0	0	1	0.0010	0.2	20		1	
GSRC 39	0.0571	12.00	7	87	2	0.0095	0.2	26		1	1
GSRC 40	0.0175	5.00	0	0	0	0.0000	0.05	12			1
GSRC 41	0.0697	15.33	0	0	4	0.0061	0.2	24	1	1	1
GSRC 42	4.0000		30	40		0.3333	0.5	36	1	1	1

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PONDBERRY DATA

Colony ID	Health of Colony	Soil Type	Iron-Rod Elevation	Average Elevation	Floodplain Frequency (years)	Depression	Comments
GSRC 29	Excellent	clay	96.1	96.27	4.5	1	huge area with many clumps, small red bugs on several leaves; insect use of leaves with web; good diversity of plant sizes (2.5 ft-1 ft)
GSRC 30	Excellent	clay	96.03	96.10	4.0	1	big colony with tall plants; one clump had plant 4'10" tall; thick vines but still healthy colony; depressions throughout area
GSRC 31	Excellent	clay loam	96.19	96.08	4.0	1	big clump of females with lots of fruit; very large colony with tall stems and little competition; 31a is SSW of plot flagged separately
GSRC 32	Good	clay	96.21	96.16	4.0	1	insect use of leaf; GSRC32-34 colonies very close but still very distinct colonies; in the middle of a cutover area
GSRC 33	Good	clay loam	95.81	96.17	4.0	1	lots of competition from vines and trumpet creeper; also in middle of clear cut
GSRC 34	Good	clay loam	95.87	95.90	3.5	1	60 yards from a cypress tree, 50 ft from clear cut
GSRC 35	Good	clay loam	95.66	95.67	3.0		35 ft (243) from boundary is one small plant; 2 garder snakes seen; in a clear cut circle; logging road within 25ft
GSRC 36	Good	clay loam	96.17	96.32	4.0	1	lots of competition from everything- just south of sweetgum research area
GSRC 37	Excellent	clay loam	96.91	97.02	6.0	1	very thick with lots of competition; huge range of plants-diameter .25-.5, height 2"-5'3", 3-60 fruits on females
GSRC 38	Good	loamy clay	96.95	97.08	6.0	1	100 ft E of GSRC 37; thick understory but less competition with vines than others in this compartment; near edge of cane field
GSRC 39	Excellent	clay loam	94.38	94.56	2.5	1	200 ft S of field, very open area with tall tress and little growth on ground
GSRC 40	Good	clay loam	94.05	94.21	2.0	1	20 ft from GSRC 39, very open area; 110 ft from small pond, in a depression with water marks on trees
GSRC 41	Excellent	loamy clay	93.93	94.28	2.0	1	very open area with little herbaceous cover; 200 ft due South from GSRC 40; very healthy large colonies; 41a is 1 plant outside of plot, 41b is 2 plants farther south from 41a
GSRC 42	Excellent	clay loam	93.85	94.20	2.0	1	plot sub-sampled; huge, very healthy colonies throughout entire area with little herbaceous cover

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Colony ID	Compartment	Date	Percent Canopy Cover	DBH (in)	Herbaceous cover	Tree Stand Maturity	No. Clumps	No. Stems	Area of Plot (ft^2)
GSRC 43	16	24-May-00	85	23.50	20%	>18	1		2400
GSRC 44	38	24-May-00	75	21.00	85%	>18	5	72	6160
GSRC 45	47	24-May-00	85	21.00	90%	Mixed	1		357
GSRC 46	47	24-May-00	85	21.60	85%	Mixed	8	258	2610
GSRC 47	Shelby	19-Jun-00	80	11.86	60%	6-18			3850
GSRC 48	Shelby	19-Jun-00	65	12.50	35%	Mixed			8400
GSRC 49	Merigold	19-Jun-00	90	9.85	40%	Mixed	4	212	1500
GSRC 50	Shelby	8-Jun-00	40	19.50	95%	6-18	1		--
GSRC 51	Shelby	8-Jun-00	75	15.70	35%	Mixed			--
GSRC 52	Shelby	8-Jun-00	65	17.50	35%	>18	1	219	--
GSRC 53	14	9-Jun-00	70	27.25	90%	Mixed			2400
GSRC 54	25	9-Jun-00	70	20.60	98%	6-18			--
GSRC 55	30	9-Jun-00	87	29.00	94%	6-18			456

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Colony ID	Stems per ft^2	Stems within Clump	No. Females	No. Fruits	No. Dead Stems	Dead Stems per ft^2	Avg. Diameter of Stems (in)	Avg. Height of Stems (in)	Fungal Damage	Insect Damage	Dieback
GSRC 43	5.6700		109	141		0.6667	0.4	42	1	1	1
GSRC 44	0.0117	14.40	0	0	0	0.0000	0.2	14	1	1	1
GSRC 45	4.0000		0	0		0.8333	0.325	41	1	1	1
GSRC 46	0.0989	32.25	6	37	6	0.0023	0.2	18	1	1	1
GSRC 47	21.3300		0	0		20.3333	0.3125	27	1	1	1
GSRC 48	5.6000		0	0		2.2000	0.5	62	1	1	1
GSRC 49	0.1413	53.00	0	0	0	0.0000	0.25	18	1	1	1
GSRC 50	0.7700		0	0		0.7667	0.875	39		1	1
GSRC 51	3.3300		0	0		2.1400	0.2	32			1
GSRC 52	6.0700	219.00	0	0	38		0.375	29			1
GSRC 53	6.0600		0	0		2.0667	0.15	18			1
GSRC 54	3.1300		0	0		0.4667	0.2	29	1	1	1
GSRC 55	10.2000		9	40		0.9333	0.2	16		1	1

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Colony ID	Health of Colony	Soil Type	Munsell Soil Color	Distance to Water (ft)	Iron-Rod Elevation	Average Elevation	Floodplain Frequency (years)	Depression	Comments
GSRC 43	Excellent	clay loam	0-3 organic; 3-12 10YR5/2, 35% mottling, 10YR5/6	--	94.13	94.46	2.5	1	plot sub-sampled; huge, very healthy colonies with little herbaceous cover; pondberry dispersed in between the very large clumps
GSRC 44	Good	clay loam	0-3 organic; 3-12 10YR4/2, 30% mottling, 10YR4/6	62	93.07	93.19	3.0	1	in the middle of a tree stand that is the middle of a clear cut area; some competition with vines
GSRC 45	Excellent	clay loam	0-4 organic; 4-12 10YR5/3, 30% mottling, 7.5YR5/6	--	94.52	94.47	4.5		plot sub-sampled; 100 ft from edge of forest-right in corner near clear cut
GSRC 46	Good	clay loam	0-4 organic; 4-12 10YR5/3, 30% mottling, 7.5YR5/6	--	94.52	94.30	4.0	1	one female has lots of dieback; this colony is very spread out
GSRC 47	Poor	clay	0-2 organic; 2-4 10YR4/1; 4-12 qoYR4/1, 30% mottling, 10YR5/6	--	154.64	154.80	>100-YEAR	1	whole area sub-sampled and plot sub-sampled; lots of dieback and dead stems; in area that frequently floods
GSRC 48	Fair	clay	0-2 organic; 2-4 10YR4/1; 4-12 qoYR4/1, 30% mottling, 10YR5/6	--	154.57	154.78	>100-YEAR	1	whole area sub-sampled and plot sub-sampled; lots of dieback and dead stems
GSRC 49	Fair	clay loam	0-1 organic; 1-12 10YR4/2	--	137.95	135.93	>100-YEAR	1	all submerged in water from nearby rice fields; pondberry wilted
GSRC 50	Excellent	clay	0-2 organic; 2-8 10YR5/1, 25% mottling, 10YR6/8; 8-12 gley 5N	--	154.50	154.50	>100-YEAR	1	plot sub-sampled; ground was dry it normally holds water; very thick clumps within entire area; quite a few dead stems and dieback
GSRC 51	Excellent	clay	0-2 organic; 2-8 10YR5/1, 25% mottling, 10YR6/8; 8-12 gley 5N	--	154.50	154.50	>100-YEAR	1	plot sub-sampled; this colony had slightly more competition from vines; next to road\
GSRC 52	Excellent	clay	0-2 organic; 2-8 10YR5/1, 25% mottling, 10YR6/8; 8-12 gley 5N	--	154.50	154.50	>100-YEAR	1	whole plot measured; ground definitely holds water
GSRC 53	Good	clay	0-2 organic; 2-12 10YR4/1	--	91.01	91.43	--	1	plot sub-sampled; dieback and dead stems
GSRC 54	Good	clay	0-12 10YR5/1, 15% mottling, 10YR4/6	--	89.62	89.88	0.8	1	plot sub-sampled; slight slolpe S to N; understory more dense than overstory; low dieback
GSRC 55	Fair	clay	0-3 organic; 3-12 10YR5/1, 25% mottling, 10YR5/6	--	95.57	95.59	4.0	1	plot sub-sampled;high percent shrub canopy; snail eating several plants; stems are very scattered and have

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Colony ID	Compartment	Date	N	E	Percent Canopy Cover	DBH (in)	Herbaceous cover	Tree Stand Maturity	No. Clumps	No. Stems	Area of Plot (ft^2)
GSRC 56	28	9-Jun-00	3624966	705812	83	13.00	95%	Mixed			2100
GSRC 57	Merigold	19-Jun-00	3743995	716790	90	12.00	30%	>18	6	199	1400
GSRC 58	Merigold	19-Jun-00	3743955	716834	75	10.44	45%	Mixed	2	177	1750
GSRC 59	Merigold	20-Jun-00	3753605	716162	80	21.08	80%	Mixed	1	500	2400
GSRC 60	Merigold	20-Jun-00	3745022	716779	95	13.67	65%	Mixed	1	37	200
GSRC 61	Merigold	20-Jun-00	3745011	716758	80	10.94	50%	Mixed	4		2015
GSRC 62	Merigold	20-Jun-00	3744991	716747	85	10.75	65%	Mixed	3	250	3500

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Colony ID	Stems per ft^2	Stems within Clump	No. Females	No. Fruits	No. Dead Stems	Dead Stems per ft^2	Avg. Diameter of Stems (in)	Avg. Height of Stems (in)	Fungal Damage	Insect Damage	Dieback
GSRC 56	6.2700		0	0		0.1333	0.2	26			1
GSRC 57	0.1421	33.17	0	0	64	0.0457	0.25	13		1	1
GSRC 58	0.1011	88.50	0	0	51	0.0291	0.25	18		1	1
GSRC 59	0.2083	500.00	0	0	125	0.0521	0.25	17		1	1
GSRC 60	0.1850	37.00	0	0	8	1.6667	0.25	21		1	1
GSRC 61	5.2700		0	0		1.6667	0.375	29		1	1
GSRC 62	0.0714	83.33	0	0	54	0.0154	0.375	32		1	1

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Colony ID	Health of Colony	Soil Type	Munsell Soil Color	Distance to Water (ft)	Iron-Rod Elevation	Average Elevation	Floodplain Frequency (years)	Depression	Comments
GSRC 56	Excellent	clay loam	0-2 organic; 2-12 10YR5/1, 25% mottling, 10YR5/6	--	88.17	88.26	0.7	1	plot sub-sampled; herbaceous cover outside colony low outside of colony; thickest stand of pondberry measured
GSRC 57	Fair	clay loam	0-1 organic; 1-12 10YR4/2	0	137.95	135.98	>100-YEAR	1	submerged in water from nearby rice fields; plants wilted
GSRC 58	Fair	clay loam	0-1 organic; 1-12 10YR4/2	0	137.95	135.93	>100-YEAR	1	submerged in water from nearby rice fields; plants wilted
GSRC 59	Fair	clay loam	0-1 organic; 1-12 10YR4/1, 10% mottling, 10YR/6	0	137.88	135.81	>100-YEAR	1	submerged in water from nearby rice fields very recently (within this week); plants wilted
GSRC 60	Fair	clay loam	0-1 organic; 1-12 10YR4/1, 10% mottling, 10YR/6	10	138.84	136.03	>100-YEAR	1	near rice fields; some area surrounding pondberry submerged but not in actual plants yet; some wilting
GSRC 61	Good	clay loam	0-1 organic; 1-12 10YR5/1, 10% mottling, 10YR/6	25	138.84	136.25	>100-YEAR	1	plot sub-sampled; right next to rice field with standing water
GSRC 62	Good	clay loam	0-1 organic; 1-12 10YR5/1, 10% mottling, 10YR/6	15	135.99	136.21	>100-YEAR	1	large colony with 3 distinct clumps; no standing water but flooded often; in the middle of 3 wheat fields and 1 rice field

APPENDIX C

LIST OF ASSOCIATED SPECIES

APPENDIX C

Number of Colonies	Common Name	Scientific Name
OVERSTORY		
41	Sweetgum	*Liguidambar styraciflua*
6	Pecan sp.	*Carya sp.*
14	Overcup oak	*Quercus lyrata*
12	Water oak	*Quercus nigra*
19	Willow oak	*Quercus phellos*
8	American elm	*Ulmus americana*
17	Nuttall oak	*Quercus nuttallii*
12	Water hickory	*Carya aquatica*
3	Cypress	*Taxodium distichum*
7	Green ash	*Fraxinus pennsylvanica*
4	Sugar berry	*Celtis laevigata*
4	Persimmon	*Diospyros virginiana*
1	Red maple	*Acer rubrum var. drummondii*
1	Southern red oak	*Quercus falcata* var. *falcata*
UNDERSTORY		
39	Sweetgum	*Liguidambar styracuflua*
15	Red maple	*Acer rubrum var. drummondii*
25	Sugar berry	*Celtis laevigata*
5	Pecan sp.	*Carya sp.*
13	American elm	*Ulmus americana*
3	Blackgum	*Nyssa sylvatica var. biflora*
7	Basswood	*Tilia heterophylla*
2	Water oak	*Quercus nigra*
7	Willow oak	*Quercus nigra*
1	Chestnut oak	*Quercus prinus*
7	Box elder	*Acer negundo*
3	Swamp dogwood	*Cornus drummondii*
1	Red mulberry	*Morus rubra*
4	Nuttall oak	*Quercus nuttallii*
5	Green ash	*Fraxinus pennsylvanica*
2	Sassafras	*Sassafras albidum*
5	Persimmon	*Diospyros virginiana*
1	Mockernut hickory	*Carya tomentosa*
1	Deciduous holly	*Ilex decidua*
1	Cedar elm	*Ulmus crassifolia*
2	Water hickory	*Carya aquatica*
1	Southern red oak	*Quercus falcata* var. *falcata*

Number of Colonies	Common Name	Scientific Name
SHRUBS		
20	Sabal palm	*Sabal minor*
30	Persimmon	*Diospyros virginiana*
38	Deciduous holly	*Ilex decidua*
51	Sugar berry	*Celtis laevigata*
5	Honey locust	*Gleditsia triacanthos*
15	Pecan	*Carya sp.*
39	Swamp dogwood	*Cornus drummondii*
13	Water oak	*Quercus nigra*
22	Willow oak	*Quercus phellos*
2	Chestnut oak	*Quercus prinus*
2	Overcup oak	*Quercus lyrata*
12	Nuttall oak	*Quercus nuttallii*
31	American elm	*Ulmus americana*
29	Red maple	*Acer rubrum var. drummondii*
20	Red mulberry	*Morus rubra*
16	Am. Snowbell	*Styrax americana*
13	Cedar elm	*Ulmus crassifolia*
20	Black hawthorn	*Crataegus douglasii*
34	Green ash	*Fraxinus pennsylvanica*
20	Box elder	*Acer negundo*
14	Sweetgum	*Liguidambar styracuflua*
4	Blackgum	*Nyssa sylvatica var. biflora*
2	Green hawthorn	*Crataegus viridis*
2	Sassafras	*Sassafras albidum*
4	Winged elm	*Ulmus alata*
1	Mimosa	*Albizia julibrissin*
1	American elder	*Sambucus canadensis*
2	Buttonbush	*Cephalanthus occidentalis*
2	Swamp privet	*Forestiera acuminata*
1	Mockernut hickory	*Carya tomentosa*
HERBS AND VINES		
61	Poison ivy	*Toxicodendron radicans*
49	Muscadine	*Vitis rotundifolia*
41	Virginia creeper	*Parthenocissus quinquefolia*
40	Trumpet creeper	*Campsis radicans*
47	Pepper vine	*Ampelopsis arborea*
24	Fox grape	*Vitis labrusca*
38	Rattan	*Berchemia scandens*
31	Blackberry	*Rubus sp.*
23	Wild lettuce	*Lactuca sp.*
29	Spanish nettle	

Number of Colonies	Common Name	Scientific Name
32	False nettle	*Boehermia cylindrica*
11	Eupatorium	*Eupatorium sp.*
8	Ebony spleenwort	
5	Sorrel	*Oxalis sp.*
5	Sassafras	*Sassafras albidum*
26	Persimmon	*Diospyros virginiana*
37	Lady's ear drops	*Brunnichia cirrhosa*
8	Moonseed	*Menispermum canadense*
50	Green briar	*Smilax sp.*
32	Rhynchosia	*Rynchosia tomentosa*
14	Pokeweed	*Phytolacca americana*
21	Swamp violet	*Viola sp.*
1	Hydrocotyle	*Hydrocotyle bonariensis*
2	Goldenrod	*Solidago sp.*
17		*Chaerophyllum tainturieri*
16	Grass	*Carex sp.*
1	Red-eyed bladder wort	*Utricularia sp.*
6	dayflower	*Commelina sp.*
1	Sedge	*Cyperaceae sp.*
4	Smartweed	*Polygonum sp.*
1	Wild strawberry	*Fragaria vesca*
1	Panic grass	*Panicum sp.*
3	Mock bishop weed	*Ptilimnium sp.*
2	Lizard tail	*Saurrurus cernuus*
1	Curly dock	*Rumex crispus*
1	Dogbane	*Trachelospermum difforme*